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NOTES AND COMMENTS.

An Announcement.

We are asked to announce that Members, Associate Members, and Associates of the Institution of British Foundrymen may obtain a copy of the new rules by applying to their branch secretaries.

Eliminating a Variable.

In sympathy with all other costs, the price of moulding sands has materially appreciated. Moulding sands are seldom, if ever, bought by analysis, but if ever such a condition does generally obtain, it will be found that the greatest variable will be moisture. In paying for soda-water or patent medicines we readily recognise that we are largely buying water, but when sand is under consideration we distinctly object. This objection is aggravated when invoices are received for the transport of water at sand prices. We would, therefore, urge that all sand should be dried at 100 deg. C. at the quarries, and then sent to its destination in closed wagons. Such a drying should not break down the plasticity of the clay content. On receipt a definite quantity of water, previously determined by experiment, could always be added. The extra shilling or two per ton which the quarry owner would have to charge would be amply discounted by the fact that there would be a large quantity of sand in each ton received. We understand that one of the most important works in this country has decided on the installation of drying machines of the rotary type in their foundries, in order that the water variable shall be eliminated, and its content definitely fixed when handed over to the moulder.

The Foundrymen's Competition.

The papers already submitted as entries for the Foundrymen's Competition, coming as they do from all over the country, at least indicate the existence of a large number of foundrymen possessed of a high standard of technical knowledge and constructive ability. A keen appreciation of the necessary details which go to make up the modern foundry, the original ideas evolved to overcome practical difficulties, and in many cases expert draughtsmanship in planning the various departments and labour-saving devices, all show that there are at work influences which are having a beneficial effect upon the status of the foundryman in this country. Whilst giving due credit for what is being done in technical institutions in various centres throughout the country, the Institution of British Foundrymen is in the main responsible for instilling into the minds of foundrymen a desire to improve their positions, and to raise their profession to a level more on a par with other branches of engineering.

We may add that only by adapting the foundries of this country to modern requirements will the industry be enabled to take advantage of the information likely to be derived from Associations similar to the British Cast-Iron Research Association. In another part of this issue we report a lecture given by Mr. J. G. Pearce before that Association, in which the speaker outlined the requirements of the ironfounding industry. We fully endorse his remarks, but would emphasise that the ultimate usefulness of a Research Association is governed mainly by the extent to which the results of these investigations can be put to practical use by the industry with which it is connected. This can be only achieved by foundrymen doing their part in providing efficient methods for utilising these results.

THE FOUNDRYMEN'S COMPETITION.

FIFTY GUINEAS IN PRIZES FOR BEST DESIGN AND EQUIPMENT OF A FOUNDRY.

To mark the change over of the FOUNDRY TRADE JOURNAL from a Monthly to a Weekly publication, the Proprietors have pleasure in announcing that they are offering two Prizes of Thirty and Twenty Guineas respectively for an article dealing with the subject of the design and equipment of a Foundry (ferrous or non-ferrous), with special reference to the latest labour-saving devices and machines, internal transport and handling tackle

Competitors, by submitting articles, signify that they adhere to the following rules:—

(1) Competitors must be in the employ of an established British foundry subscribing to the FOUNDRY TRADE JOURNAL, or himself a subscriber.

(2) Articles must be illustrated with dimensioned drawing and sketches.

(3) The copyright of all papers and designs accepted for publication will become the property of the Proprietors of the FOUNDRY TRADE JOURNAL.

All papers must reach this office by Thursday, March 3rd, 1921. The decision of the Editor will in all cases be final.

FRENCH DUTIES RE-ESTABLISHED. — A French decree of December 18 re-establishes, with the corresponding coefficient, the import duty on rails, fishplates, bridges, and parts thereof, which was suspended by decree of November 30, 1914, and March 3, 1915, in cases where such materials were required for repairs on railways, etc., necessary for national defence. The duty on heavy structural iron and steel is 12 francs per 100 kilos, with a coefficient of 3, which makes the duty now in force 36 francs per 100 kilos.

London Joint City and Midland Bank, Limited.

The ordinary general meeting of the London Joint City and Midland Bank, Limited, was held at the Cannon Street Hotel, London, E.C.4, on January 28, 1921. The Right Hon. R. McKenna (chairman), in the course of his address, remarked that the smooth and beneficial working of our central banking system implies the existence of two conditions. In the first place the Bank of England must have control of its own lending powers. It has this control in dealing with the money market, but if, as is the case, the Bank is bound to lend when called upon by the Government, and if this right to borrow is habitually exercised, a rise in the Bank Rate will not necessarily check the expansion of credit. Next, the conditions must be such as to permit of a free market in gold. If our currency is at a discount in relation to its nominal gold value, raising the Bank Rate will not attract a single ounce of gold to this country. If either of these conditions fails, and still more if both of them are absent, the Bank of England cannot have the real control which it formerly exercised with such success.

Stated briefly, the Treasury policy declared early last year was, first, to stop further inflation, and then gradually to deflate.

If we look back over the history of the last century, we shall find that every period of trade prosperity has culminated in over-trading and speculation which have been brought to a close by dear money and a severe restriction of credit. A high Bank Rate is the obvious and proper instrument for putting an end to inflation due to this cause. Dear money operates quickly, and in a case of this kind prices can be brought down to their former level before there has been any general readjustment on a new level. The remedy is appropriate to a particular evil which is temporary in its nature, and should be strictly confined to the period during which the evil is in existence.

If inflation were always due to the causes just described, the problem of dealing with it would be simple. Unfortunately, however, at the present time we have to deal with inflation arising from causes other than those with which we were familiar before the war, an inflation which has not been brought about by over-trading or speculation and which is not temporary in its nature.

In dealing with inflation of the kind with which we are confronted now, dear money and a rigid restriction of credit, so far from proving an effective means of restoring trade to a wholesome condition, can only aggravate our evils. Both sets of causes inducing inflation may be present at the same time, and when this is the case a policy of dear money may be a choice of the less of two evils; but it must never be left out of sight that the inflation, which I will call speculative inflation, is necessarily only temporary, whereas the inflation which, to distinguish it in its causes from the other, I will call monetary inflation, must be regarded as more or less permanent.

In considering monetary inflation it is necessary to ask you to recall the distinction already made between the different kinds of bank advances. So far I have been speaking of the effect of loans made or purporting to be made for some object of trade or manufacture. The second category of bank loans consists of those made in order to enable the borrower to buy commodities for the purpose of consumption. Goods bought to be consumed are not ordinarily paid for out of an advance by a bank. It may happen now and then that banks make loans for this purpose, but they would be trivial in amount and are not worth considering in the general view of banking transactions.

There is, however, one case of borrowing for consumption with regard to which there is no such limitation. The inevitable borrowing by the Government during the war, borrowing on a gigantic scale and almost entirely for consumption, compels us to direct our attention to the consequences of this class of loan The total amount raised in this country for the purpose of the war was about £5,800,000,000, part lent by the public and part by the banks. As the loans remained outstanding after the commodities bought had been consumed, we reached a true condition of inflation, an immense increase of purchasing power relative to the amount of commodities available for purchase.

If permanent monetary deflation is to be accomplished, it can only be by a reduction of the purchasing power brought into existence by the great War Loans, a reduction which can only be effected by paying off part of the National Debt. But there is no means of doing this by the imposition of additional taxation without bringing immediate ruin upon our commerce and manufacture. In present circumstances the only source from which funds can be obtained for repayment of the National Debt is by economy in expenditure, and by this means alone can monetary deflation be effected, or even attempted, without permanent injury to our trade.

Correspondence.

[*We accept no responsibilities for the statements made, or opinions expressed, by our correspondents.*]

THE CASTINGS TROUBLE.

To the Editor of the FOUNDRY TRADES JOURNAL.

SIR,—In your issue of January 27, 1921, "A Buyer" has again placed before us a very self-satisfying comment of mine. Really, on reflection, I can see that I really committed an enormous offence. Fancy a foundryman uttering a word in his own defence. I suppose it won't stand a moment's reflection from the men who dominated him for so long a period. My reason for the above comments is the fact that he states that I do not regard founding as a business proposition, but rather as an "intellectual occupation."

May I say that the only annoyance I feel against buyers in general is when I meet one who tries to impress me that he is doing me a great honour in letting me do his work, and makes me tremble when I ask for payment.

Also I am very sorry that my efforts to reply to his statements did not attain to the heights expected by "A Buyer," but I only tried to make him see that we were not all "black sheep," and I am prepared to say that I do not believe that *all* buyers are avaricious. Really "A Buyer's" remark regarding the strike being undertaken to prove that the moulder was a skilled man is very amusing. Who had they to convince, seeing that in the engineering trade they hold the pride of position with regard to wages paid to tradesmen? The very fact of making a presentable casting from some of the weird-looking affairs termed patterns ought to have proved this to "A Buyer," but perhaps the low figures buyers used to obtain castings for led them to believe that they were made by a body of men. "strong in the arm, but weak in the head," and who were paid accordingly

As to trying to make the foundry attractive to boys, I can safely say that there are very few who have not devoted time and thought to this question, and who have not in the end found their labours in vain.

With regard to prices easing, have not raw materials, such as coke, iron, etc., eased also? Deliveries, too, must naturally be better on account of the general trade depression. But did "A Buyer" ever know a time of general depression, when foundries were so busy as now? What will be the position of the foundries when trade improves? Obviously not much easier than in the immediate past, and I am still inclined to adhere to my opinion of "Full Up."

May I say that the foregoing is not written for personal satisfaction. As a Britisher I can foresee that the national engineering industry will suffer from a shortage of castings, which will handicap them in the effort to obtain full production, thereby reflecting upon the whole of the nation's prosperity. But the remedy will be found by everyone concerned with the foundry, and not, as "A Buyer" suggests, by the foundry alone.

May I further explain the "knock off" as "A Buyer" has not dealt with my illustration? Foundrymen have no grievance against the buyer who rejects a casting for defects in vital parts. It was not this feature that was meant, but insignificant defects on those portions of castings which could be easily remedied, which were generally the excuse for the "knock off." Perhaps I have been indiscreet in disclosing this feature, as it may have been unknown in some parts of the country, and I apologise in advance to my fellow foundrymen who may, owing to my folly, be penalised thereby. The "cobbler" story was rather amusing, especially so the few words in brackets, "or thought he could." It appears to me that is the reason for some buyers being in their present position. They, thinking they had found a better "cobbler," but upon finding out their mistake, and on endeavouring to take their "boots" back to their original "cobbler," were surprised to find that in the interval he had found fresh business, and could not accept their custom. When I commented upon "A Buyer's" article. I was not then (or now) writing "at" him personally, but to buyers generally, trying to explain to them their mistakes in the past in handling the foundrymen, and hoping to bring about a better feeling between two bodies of men. Perhaps even "A Buyer" will admit that there is at least two sides to a question And I would willingly give him a practical illustration that there are some foundrymen who can give a square deal, both in price and delivery of castings. thus eliminating for him, to some extent, "The Castings Trouble."—Yours, etc.,

MANAGER.

SPERMOLIN, LTD., of Halifax, have been compelled, in order to cope with their increasing trade in oil for cores on the North-East Coast, to open offices at 13a, Pilgrim Street, Newcastle-on-Tyne.

The Value of Scientific Research to Iron Founding.*

By J. G. Pearce, B.Sc.

Science, which represents theory, and industry, which represents practice, are necessary to each other. Each only progress with the aid of the other. This indeed, is the reply to those who, on the one hand, having learned in the school of practical experience, scorn theory as useless, simply because they are continually estimating the influence in practice of conditions which the theoretician is unable to consider under the simplified conditions he has to adopt, and those at the other extreme who, seeing only the theoretical aspect, under-estimate the value of experience. The truth lies between the two. Theory and practice are two aspects of the same thing. Every art or craft has a scientific basis—because it has a technique of its own, a method, it employs materials, susceptible to improvement. The examination of the means whereby this improvement can be effected constitutes research. There is no antagonism between theory and practice. There may be a difference in view between men predominantly practical and predominantly theoretical, if either is unable to recognise the necessity for the work of the other. Science is so involved, practice is so vast, that it is not possible for one man to be eminent in both, but that merely renders the co-operation of both all the more necessary. As a matter of fact, the practical Englishman relies in the main upon the very qualities which science prides itself upon and on which English scientists possess, above all others, resource and adaptability, the same sureness and ease of execution, the same common sense and sense of fairness or rightness. The qualities are exercised in two different fields. There is no room for antagonism.

Reverting to the condition of science and industry, we find that hitherto industry has undoubtedly progressed in the past but in a casual and fortuitous way. It has been left to individuals to pursue improvements stimulated only by the possibility of reward. Progress has been made, but it has not been deliberately sought. To-day conditions are vastly different. Instead of fixing wages by what could reasonably be paid after all charges had been met, the tendency is to fix wages by purely social and human considerations, and to leave it to the industry to make enough profit to pay them. Instead of competing in export markets solely with other English manufacturers, it is necessary to compete with half-a-dozen other nations. In addition, a heavy burden has to be faced to make industry, especially iron-founding, more congenial and healthy for its workers. How are these to be met? The reply is that only the pursuit of science can give what is required. Scientific work has to be done in full belief that by it, progress can be made and will be made, and only by its aid can the winning of wealth from iron ore and coal be made more economical. The industry must continue to expand and progress. This systematic expansion can only be carried out by setting men aside to study every means whereby improvements can be introduced. Progress is probably not specially desirable for its own sake, but so many desirable things follow from it that we can afford to make research a profession and to encourage men to devote their lives to it. The best way to ensure development is to segregate it and provide for it separately. The way to ensure perseverance is to get able young men interested enough to make it a life study.

The conditions in the foundry industry, however, do not permit every ironfounder to set up means whereby this can be done. If they did, it would be necessary to avoid duplication and overlapping. But, on the whole, the foundries in this country are small and numerous. Very few can afford to maintain even a chemist for necessary control of casting analysis. Clearly co-operation is desirable. This does not render competition between foundries less effective. The success of a foundry, like any other manufacturer, depends not so much on what he knows but upon how well he applies what he knows—that is, upon the excellence of his organisation. In any case, it is desirable that English manufacturers should combine to meet foreign competition rather than compete amongst themselves for a limited home market. By co-operation the whole industry will be raised to a higher level.

The Cast-Iron Research Association.

The Association is the ideal solution, ideal at any rate if the overwhelming majority of founders become members. It has been repeatedly said in the past that English manufacturers have not made sufficient use of the services of scientific men. In so far as this is true, it may be as much due to scientists as to manufacturers. But the main difficulty has been the lack of a suitable means whereby the services of scientists could be utilised. There has been no lack of chemists and metallurgists in foundry practice, but they are too much occupied in routine production to be able to prepare for the future. The Research Association scheme will provide this means. Through the Association cast-iron research will be assured a permanency which could be guaranteed by not even the largest firms.

What can the Research Association do for ironfounders? It can do much. If we consider this provision of means for research as the machinery whereby systematic progress in the industry can be made, the field of work open to the Association is extraordinarily wide. Great Britain is behind both America and Germany in applied research. Through an information bureau the members of the Association should be able to obtain, translated from foreign languages if necessary, data relating to the activities of other manufacturers all over the world, and to developments in the industry. By this means considerable expenditure on original experimental work will be saved. This will form one of the most important functions of the Association. By it the fullest advantage can be taken of the work which has been done in other countries. Again, the results of scientific research cannot be fully realised in industry without the fullest co-operation of workmen in the industry. Progress means change, and without the willingness to change on the part of workers progressive measures cannot be undertaken. Generally speaking, a workman is not antagonistic to change provided it can be shown that he will not suffer as a consequence of it. He will welcome it enthusiastically if he benefits by it. The process of indicating that workers benefit by improvements wrought by science is necessarily educational, and there is no body in the industry so competent to undertake this as the Research Association. The Government backing and the fact that the staff serve, primarily, the cause of science will give them a degree of impartiality which the worker is bound to respect. It will be the function of the Association to act on behalf of the industry to educational authorities and officials, university authorities, etc. It may arrange lectures and classes, and generally foster the spread of enlightenment among both workers and employers. The presence on the council of a representative of organised labour would facilitate this aspect considerably. Ultimately the workers will feel towards research as the executive of the American Federation of Labour feels.

There are in the country many other research associations and bodies and many individual workers conducting research in which the iron-founding industry is interested. When any discovery or improvement is made bearing on the industry, it will be the task of the Association to obtain the fullest details and see that steps are taken to acquaint members. In this way studies relating to industrial fatigue, ventilation, scientific management, and to technical work affecting the industry can be utilised and applied without delay. It may fall within the province of the

* Lecture before joint meeting of the British Cast-Iron Research Association and the Institution of British Foundrymen.

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Association to suggest surveys of the sources of iron ore and coal in this country and elsewhere with a view to ascertaining how near exhaustion some of the present fields are. The Association will naturally be greatly concerned with the materials and processes of the industry with a view to their standardisation and improvement, the determination of the best way in which foundry processes may be conducted. The question of recovery of scrap and waste will become of increasing importance. The electrical engineer will desire the ironfounder to use the electric furnace. You will observe that I have left the question of pure scientific research until last, designedly, because the Association will, in the first few years of its existence be most valuable as an organised body able to act on behalf of the industry in all those matters on which the industry cannot at present speak with a united voice. For some time to come it will depend on existing laboratories.

Finally, there is the great question of fundamental scientific research by which great advances may be made. There are many types of foundry castings which do not call for particular improvement in weight or quality, but those intended for the engineering industries offer enormous opportunities in this direction. The development of increased speeds in rotating machinery continually calls for higher-grade materials, even though they are not actually in the rotating part itself. Enormous quantities of castings are exported either as castings or after assembly with other parts into machines. Diminution of weight would in the aggregate make enormous differences in transport costs and diminution in cost would greatly assist export trade. There has been a steady tendency in recent years to replace cast-iron in engines and turbines by steel or non-ferrous metals; the proportion of non-ferrous being doubled and even quadrupled, and it is doubly significant that the non-ferrous is introduced when the service conditions are especially severe or where corrosion is most to be feared—as in naval vessels, particularly submarines. This can only be overcome by a thoroughly scientific study of cast-iron, the cheapness of which gives it otherwise a considerable advantage. Immense opportunities for scientific work exist in the malleable industry. We know very little about the interactions between molten metals and moulding sands.

In the electrical industry we are great users of electrical steels and magnet steels, and we are continually being reminded of our limitations in developing new machines and new sizes of machines for super-power stations, etc., because of the restrictions imposed by the materials at present employed. Who knows but what the present distinction in manufacture between iron and steel may not be entirely removed by research? As already indicated, for purely structural parts we have been driven more and more to non-ferrous metals because of the difficulties or disadvantages of existing ferrous materials. We make all kinds of weird demands in specifications relating to limiting figures for non-metals, etc. To what extent do we really know how far this is justified? It is justified in the light of our present knowledge, and it is beyond the capacity of one man to examine further. It requires the organised efforts of many workers.

Discussion.

Mr. H. B. Weekes, in moving a vote of thanks to the lecturer, said they had listened to a most carefully-thought-out address which he thought must appeal to the intelligence of those present. Mr. Pearce had preferred to do that rather than impose upon their credulity. He hoped that the result of the meeting would be a great influx of members to the Cast-Iron Research Association. It was only on September 30 last that they held their inaugural meeting at the Queen's Hotel, Birmingham. That was just about four months ago. On that occasion a council was elected, and since that time a great deal of spade work had been done. The Association has its Memorandum and Articles of Association approved by the Government Department for Scientific Research These documents were now before the Board of Trade, and the Association was merely awaiting their approval in order to become formally established. But, at all events, some progress had been made. He would like to take that opportunity of saying that whatever fault they might find with the Government on various questions, he thought they deserved every credit for their inauguration of resarch associations. He believed there were now 27 such bodies already in existence. It would be patent to everybody who had anything to do with the drawing up of the Memorandum and Articles of Association how very great was the assistance they had received from the Government Department. The Cast-Iron Research Association meant to be a real live Association able to assist the industry. His own view was that where the theorists and the practical men did not agree there must be something wrong either with the theory or with the practice. Personally, he had very strong ideas as to what constituted an ideal founder. He would have a man if possible able to go into the drawing office and design the work to be done, equally able to go into the pattern shop and make his pattern, and he should also be able to go into the foundry to mould his work and melt his metal and cast the job. For the moment, anything like that was probably impossible, and they might consider that it was impossible to get all those virtues in one individual. If that was so, that only showed how necessary it was for all concerned with each particular detail that they should all work together in harmony in order to produce the best results.

Mr. W. R. Barclay, in seconding the vote, remarked that Mr. Pearce, towards the close of his lecture, expressed the hope that some of his hearers would realise what the British manufacturers were up against. He (the speaker) thought that that was a great need in this country. The average manufacturer in the metallurgical world had no idea of what he was up against, and he had quite failed to realise the extraordinary strides made on the Continent and in America, particularly in the way of organising research. He certainly had not realised it to anything like that extent, though he would be compelled to recognise it within the next ten years. They really needed to convert the average manufacturer of the country to the realisation of the tremendous importance of scientific research, which was so much needed in this country. In the past, Great Britain had been the leading industrial centre, and they certainly required to maintain that position.

Mr. Pearce, replying, said he had had some opportunities of knowing what had been going on in the United States of America. The manufacturers in that country had adopted scientific research, because they found it a very valuable economic weapon, which this country had not got. The Americans could not equal the English products in any market, unless they had some special weapon, and that weapon undoubtedly was scientific research. If Englishmen had the same efficient research, they could not only equal the Americans, but could beat them in competition, as they always had done.

Dr. Brownsdon, proposing a vote of thanks to the Chairman, said that wherever cast iron was mentioned, however far one might go into research on that subject, it would not be long before they came across the valuable work that Professor Turner had done in that department, and they felt very much honoured by his presidency

Mr. F. B. Holberry (President of the Birmingham Branch of the Institution of British Foundrymen) seconded the vote of thanks on behalf of the Institution, remarking that they were all under a very great debt of obligation to Professor Turner for the valuable scientific research done by him in the past.

The Chairman, in acknowledging the vote, recalled an old quotation:—

> "Great are the dangers that environ
> Whoever meddles with cast iron."

That quotation occurred to him very early in connection with research work, but he was bound to say that he had never found that to be the case. On the contrary, his labours had led to the formation of friendships which had lasted until the present day, so that the rather gloomy prediction of the poet had not been realised, and his work had proved extremely pleasant to him.

Experiments in Malleable Iron.*

By F. H. HURREN.

Since the commencement of the present century all branches of the foundry trade have made great strides in the direction of scientific development, but it will be agreed that the malleable iron industry has shown the least progress.

Considering the causes which contribute to this regrettable state of affairs, the most potent factor has been the spirit of secretiveness which has prevailed among the many firms engaged in the industry, and the air of mystery with which many have surrounded their processes. This secretiveness is gradually being eliminated, but even now there is not that openness and frank co-operation that alone tends towards real progress. Much of the malleable iron castings which make up the output in Great Britain is produced in a very large number of small shops. In the Birmingham district there are quite a considerable number of malleable iron foundries, the individual output of which is relatively small, but making in the aggregate an important industry. Owing to their small output they are unable, or unwilling, to utilise scientific experiment, and it is this inability to co-ordinate science and industry which has retarded progress to an alarming extent. Further, the scientific work on malleable iron, which has been published is scattered so widely through the technical journals and the proceedings of various learned societies as to make it quite a task to realise just what work has been done.

In consequence malleable iron is looked upon with a certain amount of suspicion. It is to be hoped that the recently-formed Malleable and Cast Iron Research Association will change this state of affairs and place the malleable iron industry in Great Britain in at least as important a position as it occupies in America.

All the pans were placed in the furnace together, which was heated up to 1,000 deg. C. over a period of 24 hours, and then maintained at that temperature. Sample No. 1 was removed from the furnace after standing 72 hours at 1,000 deg. C., No. 2 after 96 hours, and No. 3 after 120 hours. No. 1 was on the hard side, and not of very good

TABLE I.

Group No.	Sample No.	T.c.	C.c.	Gr.	Si.	S.	P.	Mn.	Brinell No.
1	1	2.32	1.27	1.05	0.62	0.30	0.08	0.04	—
	2	1.60	0.78	0.82	0.59	0.30	0.08	0.05	—
	3	1.25	0.61	0.64	0.56	0.22	0.09	0.05	—
2	4	1.61	0.57	1.04	0.77	0.30	0.07	0.09	—
	5	2.09	0.98	1.11	0.74	0.28	0.07	0.09	—
3	6	2.25	0.83	1.42	0.99	0.25	0.08	0.28	—
	7	2.05	1.07	1.04	0.76	0.22	0.10	0.32	—
8	8	2.83	2.68	0.15	0.64	0.25	0.07	0.24	—
	9	2.96	2.51	0.45	1.03	0.22	0.07	0.27	—
5	10	2.86	1.23	1.63	0.63	0.25	0.08	0.25	—
	11	2.55	0.79	1.76	1.09	0.22	0.07	0.29	—
6	12	1.83	0.83	1.00	0.64	0.32	0.10	0.15	—
	13	2.30	1.00	1.30	0.60	0.32	0.07	0.15	—
	14	2.40	1.22	1.18	0.58	0.32	0.08	0.15	—
	15	2.30	1.09	1.21	0.61	0.33	0.10	0.17	—
7	16	2.20	0.62	1.58	0.92	0.28	0.06	0.16	157
	17	2.28	0.61	1.67	0.93	0.27	0.06	0.16	153
	18	2.21	1.10	1.11	0.94	0.29	0.07	0.16	162
8	19	1.82	1.31	0.51	0.63	0.26	0.06	0.15	207
	20	2.20	0.60	1.60	0.61	0.28	0.06	0.15	196
	21	1.87	1.14	0.73	0.60	0.28	0.07	0.14	202
9	22	3.04	0.42	2.62	0.90	0.29	0.07	0.05	—
	23	3.00	0.19	2.81	0.91	0.28	0.07	0.07	—
	24	3.15	0.35	2.80	0.89	0.27	0.06	0.07	—
	25	2.98	0.18	2.80	0.88	0.26	0.06	0.05	—
11	29	2.60	0.60	2.00	1.05	0.30	0.13	0.19	—
	30	2.26	0.88	1.38	0.70	0.26	0.16	0.09	—
	31	2.12	0.84	1.28	0.61	0.28	0.07	0.13	—

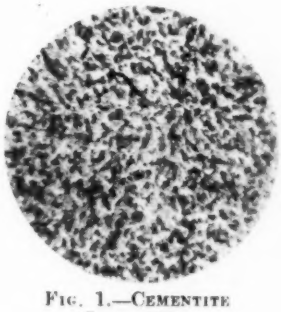

FIG. 1.—CEMENTITE STRUCTURE.

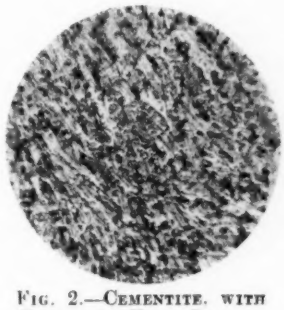

FIG. 2.—CEMENTITE, WITH TRACES OF FREE CARBON.

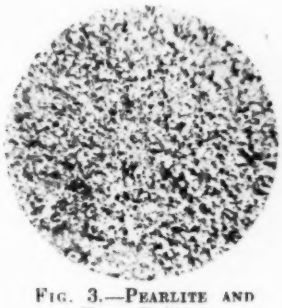

FIG. 3.—PEARLITE AND FREE CARBON.

At the works in which the author is interested experimental work on malleable iron has been conducted regularly for many years. Much of this has been routine work; some has been on purely experimental lines. The details which it is proposed to give on this occasion do not represent the only work which has been carried out, nor, on the other hand, do they represent all the work conducted. Many of these experiments have been repeated several times, and those dealt with this evening are typical examples. It should be emphasised that all these experiments have been carried out under ordinary works conditions, and not under purely laboratory conditions. All mixtures have been melted in the cupola, all annealing conducted either in the works annealing furnaces, or in a smaller furnace specially installed in the foundry for experimental purposes. Temperatures have been taken by means of a thermo-couple, of the type fitted as standard in the annealing ovens, and in most cases in conjunction with a thread recorder.

Group I. Table 1 gives the analyses of three samples. All of these were cast out of the same shank, in the same moulding box, and were identical in size and shape. The iron was melted in the cupola from a mixture of 25 per cent. spotted white pig, 25 per cent. grey pig, and 50 per cent. scrap and runners from previous casts. The samples were packed in separate pans in a mixture of six parts of black ore to one part of red.

* Lecture read before the Birmingham Branch of the Institution of British Foundrymen's Association.

machining qualities. Nos. 2 and 3 were both soft, easily machinable, and it was impossible, in ordinary machine-shop practice to detect any appreciable difference. The marked differences will be noticed in the total carbon and in the combined carbon content. In samples 2 and 3 the proportions of combined and free carbon are almost the same, and, as repeatedly observed, that where the free carbon equals the combined carbon, no matter what the percentage, a good, soft, machinable iron results.

Group 2 gives the analysis of two samples identical in composition when cast, annealed for the same length of time, and at the same temperature, namely, 120 hours at 980 deg. C., slowly cooled during 24 hours to 900 deg., and then at a slightly quicker rate. The variable factor in this case was the packing medium. No. 4 was packed in a mixture composed of six parts of black ore to one part red ore. No. 5 was annealed in this mixture of ore, to which 20 per cent. by volume of common washing soda had been added. Both resulted in soft castings, with the balance in favour of No. 4. This contains less total carbon, and considerably less combined carbon than No. 5. Washing soda is not recommended as an addition to the annealing ore, owing to the great difficulty of cleaning the castings. The soda causes the ore to cake, and it requires considerable effort to get the castings out of the annealing pan.

In Group 3 are results obtained after the introduction of steel scrap into the malleable iron. The mixtures were melted in the cupola, No. 6

being a mixture of 60 per cent. steel scrap in the form of short ends from bars. No. 7 consisted of a mixture of 50 per cent. grey pig and 25 per cent. each spotted white pig and steel scrap. Both samples were annealed in the same pan, and the heat treatment was 40 hours heating up to 950 deg. C., when the temperature was maintained at that point for a further one hundred hours, followed by slow cooling. Both samples gave good results, and so far as can be seen there are no practical difficulties in using steel scrap.

Further experiments were made in connection with the introduction of steel scrap, and Group 4 gives the analyses. Sample No. 8 was cast from a mixture of 25 per cent. grey pig, 50 per cent. spotted white, and 25 per cent. runners and scrap from a previous cast. Sample No. 9 was cast from 50 per cent. grey pig, 16 per cent. spotted white, and 34 per cent. steel scrap. Both samples were annealed together as in the previous experiment, but withdrawn from the furnace after 60 hours at 950 deg. C. As may be imagined from the analyses, both were hard, due chiefly to the shortness of time allowed for heat treatment. No. 8 was practically unmachinable, but No. 9 could be turned or drilled at slow speed. The reason for No. 9 being the softer lies in the fact that its silicon content is higher, and is not due in any measure to the presence of steel scrap. It has been satisfactorily proved that malleable pig will take up to 25 per cent. scrap without detriment, provided the silicon content of the resultant mixture is not allowed to fall below 0.65 per cent.

In evidence of this, further samples of castings made from the mixtures just mentioned were annealed for 96 hours at 950 deg. C., after a heating-up period of 40 hours, and slowly cooled. Analyses of these samples are given in Group 5. It will be observed both samples now contain large percentages of free carbon, namely, 1.63 and 1.76 per cent., against 0.15 and 0.45 per cent. after the short anneal. Both were well annealed, soft, and easily machinable. One peculiar fact is noticeable, and this has occurred in other experiments of the same nature. In the ordinary mixture (containing no steel) the total carbon was practically the same after the short anneal and the long anneal, 2.83 and 2.86 per cent. respectively. In the steel mixture there is a considerable diminution of total carbon in the long anneal, viz., 2.55 per cent. against 2.96 per cent. in the short anneal. As the example just cited is not an isolated one, any suggestion proving a reason for this increased elimination of carbon when steel has been added should be interesting.

Group 6 gives particulars of an experiment in which the variable was the packing medium. All samples were cast from the same shank of metal, annealed for 120 hours at 950 per cent. C. after a heating-up period of 38 hours. No. 12 was packed in a mixture of six parts of black ore to one part of red; No. 13 was packed in coarse coke dust; No. 14 was packed in black sand from the foundry floor; and No. 15 in two parts of black sand to which had been added one part of fine red annealing ore. All these samples came out clean and free from scale or adhering packing, with the exception of No. 15, the packing of which had caked slightly, but came away cleanly from the casting. No. 12 was undoubtedly the best malleable and most easily machinable, but little fault could be found with the others, No. 14 being, if anything, the hardest. The total carbon in the material, as cast, was 3.3 per cent., so that all suffered an elimination of carbon, but none so great as that packed in the standard ore mixture.

During the ordinary run of foundry work it usually happens that the moulders are several days in front of the annealing ovens, and castings are fettled and stacked in the yard awaiting packing. In wet weather these castings are liable to rust, and it was therefore desirable to determine if rust had any effect on the annealing. A number of samples were cast and divided into three lots, another lot sandblasted, and the third lot, after sand-blasting, left in a damp place until quite rusty. These were all packed in the same pan, and annealed for 91 hours at 950 deg. C. The results are shown in Group 7. Sample No. 16 was brushed, No. 17 sandblasted, and No. 18 rusted after sandblasting. The sandblasted casting (No. 17) was the softest and most easily machinable. It also contains the highest total carbon and free carbon. The rusty casting shows the lowest free carbon and the highest combined carbon. These results were so peculiar that they were repeated several times. A further batch is shown in Group 8, in which Sample No. 19 was brushed, No. 20 sandblasted, and No. 21 rusted after sandblasting. The annealing was varied somewhat in this experiment, being over a period of 61 hours at 950 deg. C., followed by several hours' slow cooling to 800 deg. C., after which the furnace was reheated to 950 deg. C., and maintained at that temperature for a further 71 hours. Here again it will be noticed that the sandblasted casting, No. 20, contains the highest total carbon and free carbon; but in this experiment the "brushed" casting, No. 19, contains the lowest free carbon and the highest combined carbon. It appears from this that castings cannot be too clean at time of packing, and the best results are obtained where it is possible to use the sandblast.

The method of packing ovens in tiers so many pans high is well known to everyone. To ascertain if position in the oven had any influence on the final composition, other factors remaining the same, two series of experiments were carried out, some results of which are shown in Group 9. A number of test-bars were cast from the same shank and all of the same size. These were packed in a standard annealing oven in one stack, the first, No. 22, being in the bottom pan, No. 23 in the second pan up, No. 24 in the third pan up, and No. 25 in the top pan. Each set of bars were carefully placed in the same relative position in each pan. As will be seen from the analyses, there was practically no difference in the results. All were soft, easily machinable, malleable castings, and there was little or no variation in the composition.

As a continuation of this experiment, a further set of bars from the same cast were annealed, but in this instance were packed in the third pan up in each stack; No. 26 being in the back stack, No. 27 in the middle stack, and No. 28 in the front stack, i.e., nearest the charging door. Tensile tests only were taken on these, and the results are given in Table 2. Again there is little to choose, the only difference of any note being the rather lower yield point of the sample annealed in the back row.

During certain periods much trouble was experienced with accumulations of low silicon pig (0.4 to 0.5 per cent.) and the fact that little or no malleable pig of higher silicon was available to mix with it. In consequence, some difficulty was experienced in annealing. In the yard there was a fairly large quantity of an East Coast hematite pig, averaging about 3.7 per cent. silicon. Vary-

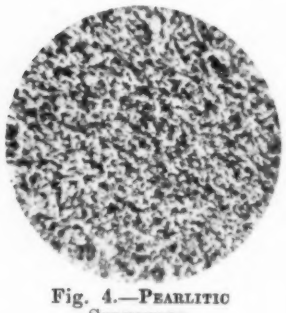

Fig. 4.—PEARLITIC STRUCTURE.

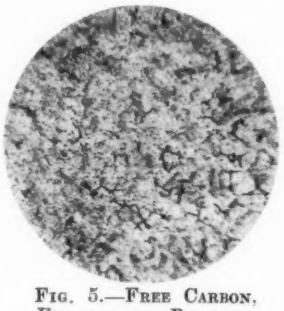

FIG. 5.—FREE CARBON, FERRITE AND PEARLITE.

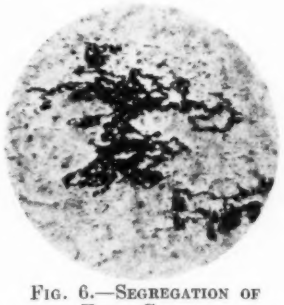

FIG. 6.—SEGREGATION OF FREE CARBON.

ing quantities of this were mixed with the white pig, and samples and test-bars cast. Group 11 gives the analyses of these samples, No. 29 with 10 per cent. hematite added, No. 30 with 7½ per cent., and No. 31 with 6¼ per cent. All these mixtures were melted in the cupola, and the various samples then annealed together in the same pan. All gave remarkably good specimens of malleable iron, of good mechanical properties. The results of the tensile tests are included in Table 2. From this it will readily be seen that no fault could be found with these mixtures. Many tons of malleable castings have been made from the mixture containing 7½ per cent. hematite.

TABLE II.

Sample No.	Max. stress. Tons per sq. in.	Yield point. Tons per sq. in.	Elongation. Per cent. on 1½ in.
26 ..	29.5 ..	18.0 ..	3.5
	30.2 ..	18.4 ..	3.5
27 ..	29.2 ..	21.0 ..	3.5
	30.2 ..	21.5 ..	3.5
28 ..	26.4 ..	22.0 ..	3.0
	30.4 ..	20.6 ..	3.5
29 ..	27.4 ..	17.9 ..	4.5
	30.2 ..	18.5 ..	5.0
30 ..	26.8 ..	18.1 ..	4.5
	29.3 ..	20.2 ..	3.5
31 ..	26.0 ..	18.9 ..	4.5
	24.8 ..	20.2 ..	4.5

Of a particular series of experiments four types of test-casting were made, all of them being 1 in. wide by 1½ in. long, but of different thicknesses. No. 1 casting was ¼-in. thick. No. 2 was ½-in. thick, No. 3 was ¾-in. thick, and No. 4 1-in. thick. A large number of each of these were made, care being taken to ensure all being cast from the same shank. Three batches, each consisting of one casting of each thickness, were made up in annealing pans, each batch being in a separate pan. These batches are designated A, B, and C, and the individual castings numbered 1 to 4. The oven containing the first three batches was lighted off, and raised to 950 deg. C. The temperature was maintained at this point with as little variation as possible for 72 hours, when Batch A was removed and allowed to cool fairly rapidly, but the castings not removed from the pan until quite cold. The furnace temperature was then reduced very gradually during 18 hours, until it reached 800 deg. C. Batch B was then removed and treated similarly to A. The furnace was then cooled off to 600 deg. C. during four hours, when the heat was shut off, and Batch C left in the furnace until quite cold. Table 3 gives the analyses of the various batches. As may be imagined, all of these were hard, but several curious points arose. No. 1, which was ¼-in. thick, does not lose nearly so much total carbon as No. 4, which was 1-in. thick, yet No. 2, which was ½-in. thick, loses much more than the ¾-in. sample No. 3. The amount of free carbon is practically the same in each one. The Brinell numbers are included, although the author came to the conclusion long ago that the Brinell is useless for castings. Strange to say, the sample which shows the lowest Brinell, and should be the softest, contains the highest percentage of combined carbon.

TABLE III.

Sample No.	T.c.	C.c.	Gr.	Si.	S.	P.	Mn.	Brinell
A 1 ..	2.77	2.73	0.04	0.68	0.26	0.05	0.14	262
A 2 ..	2.08	2.02	0.06	0.68	0.26	0.05	0.13	255
A 3 ..	2.84	2.78	0.06	0.69	0.24	0.05	0.14	241
A 4 ..	2.18	2.10	0.08	0.70	0.25	0.05	0.14	302
B 1 ..	1.44	1.37	0.07	0.70	0.26	0 06	0.12	228
B 2 ..	2.48	2.40	0.08	0.73	0.25	0.05	0.13	228
B 3 ..	2.68	2.57	0.11	0.74	0.25	0.06	0.13	212
B 4 ..	2.62	2.42	0.20	0.74	0.25	0.06	0.14	255
C 1 ..	2.44	2.38	0.06	0.68	0.23	0 08	0.12	241
C 2 ..	2.62	2.54	0.08	0.70	0.23	0.07	0.13	228
C 3 ..	*2.66*	*2.60*	*0.06*	*0.70*	*0.23*	*0.07*	*0.13*	*241*
C 4 ..	*2.38*	*2.28*	*0.10*	*0.68*	*0.23*	*0.08*	*0.13*	*255*
D 1 ..	1.56	1.48	0.08	0.75	0.24	0.07	0.12	202
D 2 ..	2.50	2.44	0.06	0.75	0.25	0.07	0.12	255
D 3 ..	2.07	1.97	0.10	0.75	0.24	0 06	0.13	228
D 4 ..	2.81	2.73	0.08	0.73	0.24	0.06	0.12	241
E 1 ..	1.67	1.29	0.38	0.70	0.22	0.08	0.14	202
E 2 ..	1.71	0.71	1.00	0.70	0.22	0.09	0.14	207
E 3 ..	2.04	1.01	1.03	0.70	0.22	0.08	0.13	202
E 4 ..	2.54	1.22	1.32	0.70	0.22	0.08	0.14	207
F 1 ..	2.46	1.20	1.26	0.70	0.23	0.09	0.11	163
F 2 ..	1.99	1.11	0.88	0.70	0.23	0.08	0.11	196
F 3 ..	*2.58*	*1.35*	*1.23*	*0.70*	*0.23*	*0.08*	*0.12*	*187*
F 4 ..	*2.72*	*1.43*	*1.29*	*0.70*	*0.23*	*0.08*	*0.13*	*196*

Passing on to Batch B, much the same results are shown. The free carbon is slightly higher, and here again the lowest Brinell number is recorded by the sample having the highest percentage of combined carbon. Sample B 1 is rather peculiar in showing a very low total carbon, much lower than any in the preceding table.

The analysis of Batch C gives figures very similar to those just referred to. All the samples in each batch were hard and difficult to machine. This is only to be expected from the short heat-treatment.

Further batches of samples from the same cast were taken as before, packed in the same strength of ore, and placed in the annealing furnace. These batches have been called D, E, and F. The furnace was raised to 950 deg. C., and instead of maintaining steadily at this temperature for 72 hours as in the previous experiment, it was kept at this temperature for 18 hours, then cooled to about 850 deg. C., and allowed to reman at or below this temperature for six hours. The temperature was then raised again to 950 deg. C., kept at this for another 18 hours, and the cooling process repeated. This treatment was carried out for a third time, giving a total heat treatment of 72 hours, out of which 54 hours were at 900 deg. to 950 deg. C., and 18 hours below 900 deg. C., when Batch D was removed and cooled as in previous test. The furnace temperature was then dropped slowly to 800 deg. C. during 18 hours, and Batch E removed. The furnace was cooled down to 600 deg. C. in four hours, when the heat was cut off, Batch F being left in the furnace until cold. In these two series of experiments the batches which should be strictly comparable are A and D, B and E, C and F, as each of these pairs have had the same length of time of treatment.

All the castings of Batch D were hard and difficult to drill. The loss of total carbon does not appear to be influenced by size, as D 3 loses much more than D 2. These figures are very similar to those shown for Batch A.

These castings of Batch E were much softer than Batch D, and contain quite appreciable quantities of free carbon. The results differ materially from those given for Batch B.

All these samples of Batch F were reasonably soft, and machined freely. Again it will be noticed there are considerable percentages of free carbon; also further evidence that elimination of carbon does not appear to be governed by size.

None of the samples were perfect specimens of malleable iron, owing to the shortness of the heat treatment.

As C 3 and C 4 and F 3 and F 4 are comparable, they are printed in italics. The marked difference in free carbon between C 3 and F 3 and also between C 4 and F 4, is very pronounced. It would appear from this, and also from many other experiments on the same lines, that it is not desirable to maintain a rigid temperature during annealing, nor to vary only within very narrow limits. A lowering in temperature at certain times during the process of annealing seems to favour the decomposition of the carbide and the liberation of free carbon. One other point arising from these experiments should be emphasised, that is the necessity for slow cooling. Evidence of this is supplied by the differences in composition of Batches D and F, which confirms the author's previous experience. Many annealers pull down the front wall of an oven as soon as the last fire has burned off, and expose the pans to cold air whilst they are at a bright red heat. This will undo a great deal of the good done during the annealing process. It is preferable to leave the front wall or door up, until the pans have cooled to a black heat. Time spent in cooling down slowly is not time wasted.

Before concluding, a very brief survey of the micro-structure of representative samples from each batch was given. The samples have been polished, etched with picric acid, and examined under the microscope. Sample A, Fig. 1, shows a cementite structure, but differing from that of white iron, and no free carbon is apparent. Sample B, Fig. 2, shows slight traces of free carbon, but in very small points rather than in aggregations; the structure is mainly pearlite, but cementite is still evident. Sample C, Fig. 3, free carbon is more

evident, yet still appears to be very evenly distributed. The structure is mainly pearlitic.

Sample D, Fig. 4.—This is quite different from A, the cementite having broken down, and the structure being chiefly composed of pearlite. This sample approximates more to the structure of Sample B.

Sample E, Fig. 5, shows considerable free carbon present, especially near the surface, but evenly distributed either in small pin-points or nodules, or else in fine lines. This section also shows a skin of ferrite which shades off into an area of pearlite, containing traces of cementite.

Sample F, Fig. 6.—A considerable area of ferrite with patches or segregations of free carbon. This ferrite extends to some depth; towards the centre the structure changes into pearlite and cementite.

In conclusion, the thanks of the author were expressed to the many workmen and charge-hands of the Rover Company, Limited, for their willing co-operation and assistance, and to Mr. F. H. N. Lane, B.Sc., of the same works, for carrying out the analyses.

(*Discussion—see Page* 136.)

Electrically-Controlled Mould Dryer

The Société Parisienne de Materiel de Fonderie have recently placed upon the market an electrically

FIG. 1.—A FRENCH PORTABLE MOULD DRYER.

controlled portable stove for mould drying. This new apparatus is specially designed for drying large box moulds, which would be difficult to transport to the ovens, moulds made in pits and floor moulds. It is

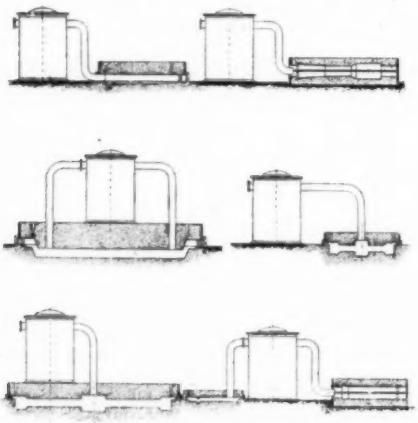

FIG. 2.—SOME APPLICATIONS OF THE MOULD DRYER.

intended to replace coke fire baskets and lamps which invariably result in imperfect and irregular drying, and completely removes the inconvenience caused by smoke to the employees. Hot air, forced by a blower, easily penetrates to the farthest corners of the mould, the vapour and gases escaping by the vents, runners and risers, according to the construction of the mould.

Additional advantages are shown on account of the complete utilisation of the hot gases, and the ability to use gas coke, particularly the riddlings coming from cupola coke.

At the outlet of the blower a double piping distributes the blast, one passing through the ash pan and grating to the combustion chamber and the other through the reheating chamber, where a series of baffles lengthen its path to the interior of the apparatus, ensuring its reheating before mixing with the combustion gas.

The inconvenience usually caused by burnt particles is eliminated by the ability to regulate the apparatus according to requirements.

Fig. 1 gives the general appearance of the apparatus and Fig. 2 some of its applications.

Core-making in France.*

Core sands should possess special qualities in reference to refractoriness, porosity, strength, and stripping properties. To obtain these, most natural sands require modifications. "Fat" sand, rich in clay, has the necessary strength for moulding, but it presents the inherent faults of clay—lack of porosity and excess of water. That is to say, the liability of blow-holes is proportional to the clay content.

To obviate this defect many foundrymen add manure to clayey sands, in order to "open" it, allow of the passing away of the gases, and to a slight extent help stripping.

"Fat" sands can be improved by the addition of "weak" sands, and it is quite good practice to add "burnt" sand. The combined water of clay, contained in the new sand, has been driven off by the heat of contact with the liquid metal, thus rendering burnt sand comparable with silica sand.

The use of old sand had become much more general during the war on account of the difficulties of supply.

In the Paris district the type of sand used for core-making is a light yellow Fontenay sand; its defect is that of clayey sands, and the material used to correct it is either molasses or dextrine. These products give porosity, and help stripping. The result is excellent when a judicious mixture of these binders is made with new sand, burnt sand, and silica sand.

Weak sands with sharp grains, if handy for use with core-making machines, have the advantage of a great porosity, which is necessary when working with semi-steel and making radiators.

Large-grained silica sand, largely used in the moulding of auto and aero engines, gives an excellent porosity and an easy stripping, so necessary in this class of work. These sands, in spite of their advantage in being pure, and not vitrifying on cooling, allowing of ideal stripping conditions, have a serious disadvantage. They do not bind at all well, necessitating the use of an artificial binder.

Linseed oil is the standard product for this purpose. After stoving, the cores are hard, and entirely satisfactory for all purposes. Unfortunately, before this operation, they are extremely fragile, and their stripping on a shaped plate is essential.

Linseed oil only obtains its binding properties after heating. The boiled oil gets thick and dry by producing linoxyn.

Frequently foundrymen do not use the boiled oil, but crude oil. In such a case it is necessary to heat up the stoves to about 300 deg. C., as the oil only transforms itself into a sort of a glue at 325 deg. C.

"Linoil," which is not comparable with linseed oil, has similar properties, with the exception that it does not require so high a temperature for baking.

Where it is impossible to de-mould on a tray, linseed oil and "linoil" ought not to be used alone. It is necessary to add to the sand a protector, which can be composed of clayey sand, an aluminous wash, rye flour, glucose, or dextrine.

The aluminous wash is not popular with foundrymen, who quite wrongly prefer clayey sand. Dextrine and glucose are old foundry materials, the uses of which are well known.

Good cores for steel moulding purposes can be made with a mixture of 48 parts of silica sand, 12 parts of flour, and 1 part of boiled oil.

ARMSTRONG, WHITWORTH & COMPANY, LIMITED, announce that they have entered into an agreement with the Russian Trade Delegation for the repair of Russia's locomotives.

* An abridged translation of a recent article appearing in "La Fonderie Moderne."

Buying Castings (II.).

The first part of this article was largely devoted to the problem of educating a foundry to the specific needs of the buyer, with a view to obtaining ultimately good results. We may now consider the general procedure for the buying of castings, apart from the judicious distribution of patterns; this applying to what may be termed standard castings, which any foundry of repute should be able to produce.

In the first instance a casting drawing is prepared, and blue print copies are issued to the buyer. It is observed that the final finish of the article should be stated on the drawing, as this will assist in the direction of getting satisfactory castings at the best possible price. For instance, the article may be (1) machine finished, (2) ordinary rough finished, (3) paint finished, (4) plated, finished, etc. Unless otherwise specified, the foundry will usually quote for (and deliver) castings for a rough finish.

The blue print is sent to the foundry, together with an inquiry for quotations. The inquiry specifies the quantity of castings required, and may also give the weight of one casting and the number of patterns available; also whether these are loose or on a plate. All this is really necessary to enable the foundry to give an intelligent quotation, for both price and delivery are obviously affected. It is of no use sending out an inquiry, the terms of which are liable to be misinterpreted, for the result will be unsatisfactory alike to the buyer and to the foundry.

An inquiry without reference to patterns (save that they will be supplied by the buyer) is read that one loose pattern will be supplied, and a quotation is made accordingly. It may be that a plate pattern is actually in existence, and so the price is much higher, and delivery much lower, than the buyer would expect, and, assuming that a similar inquiry had been addressed to another foundry which (owing to past dealings) was aware of the existence of this pattern, the first-named foundry would undoubtedly lose the order.

The inquiry, giving all the necessary information, is sent to three or four foundries, and in due course the quotations come to hand. It may be that these show a good deal of variation, but it is by no means safe to give the order to the foundry quoting the lowest figure, particularly if the order covers some hundreds of pieces. It is advisable to obtain samples before being definitely committed, but in this connection the question of delivery must be taken into consideration.

Time cannot be spent in obtaining samples from various foundries if the castings are urgently required, and it is assumed that, when this is the case, the order is placed with the foundry which has already produced castings which are more or less satisfactory. In sending out the inquiries referred to, then, we may take it that immediate delivery is not essential, and that time can be allowed in which to solicit samples.

Where, say, four quotations are received, three of which are approximately the same, whilst the fourth is considerably lower, this latter figure must be accepted with reserve. It will not do, of course, to assume that because the price is low the castings will not give satisfaction, and so turn the quotation down; neither will it do to immediately close with it. The best policy is to select one of the three figures, and place with the foundry a small trial order, at the same time placing a similar trial order with the foundry offering the lowest quotation.

When the castings are received, the products of the two foundries are compared—in the first instance without reference to price. Inspection in this case does not stop at a superficial examination, for the castings must be put into process in order to determine the suitability of the mixture from which they are made and also to determine whether they will clean up to the dimensions desired. The report is sent by the inspector to the works' manager or the shop superintendent, who holds a conference with the buyer.

The relative prices now appear for the first time in conjunction with the report. Assuming that the report shows that the low-priced castings are decidedly inferior in quality, the two prices are made known to the works' manager, who has to decide whether the low first cost justifies the acceptance of the castings. If he decides against this, the better castings at the higher figure are accepted, and in connection with future orders the buyer will rule out the foundry responsible for the inferior castings.

On the other hand, should the cheaper castings be only slightly inferior to those of the higher price, the manager (being acquainted with the cost) will probably decide that these are quite usable, and recommend acceptance. This may be considered good business, for, as before mentioned, it is highly probable that subsequent orders will be met with better finished castings, as the foundry becomes more conversant with the specific requirements of the customer. The buyer should never order a large quantity of castings from a foundry, the products of which are not known to him until samples have been submitted and approved.

It is not wise to rely entirely on one foundry, and even though satisfaction is being given, it is well to have another source of supply in reserve, and to ensure this it means, of course, that certain orders must be given to this other foundry from time to time. The buyer, strictly speaking, should never be altogether satisfied, otherwise he cannot take full advantage of the opportunities which abound. It is only by pitting one foundry against another that the best results are attained, for if a foundry knows that it has competitors, it must exert itself in order to secure business. On the other hand, once the buyer is established with a foundry which can and does give satisfaction, he must take care never to lose his hold, for he may find himself in a serious position should his latest choice fail him.

The buyer now has an opportunity for doing real business, if only he will avail himself of it, and in this respect it is not advocated that prices be ground down to a very low level. It is known that many firms, in order to secure business, will quote a price which is far too low to be considered a paying proposition, and although the buyer reaps an advantage on the first order, the chances are that he will be the loser subsequently, unless stringent precautions are taken. The firm (whether this is represented by a foundry or other business) cannot afford to work below cost, and in time either the quality of the work deteriorates or the price must be increased.

It is up to the buyer, however, to bring down prices from their present high level, and to compel the foundries to introduce new methods and thus cheapen production. Whilst the founder can command the price, he is quite content to continue, but when he is compelled to fight for business, he realises that the old way is not good enough, and that he must look ahead. He must revert to the policy of quick returns and small profits, but as this policy cannot be adopted under present methods, then the methods must be changed. It is here that the buyer can assist, and in so doing benefit, not only the founder, but also himself.

A BUYER.

Book Review.

Domestic Fuel Consumption. By A. H. BARKER. London: Constable & Company, Limited, 10, Orange Street, Leicester Square, W.C.2. (Price 14s. net.)

The present work had its origin in a series of public lectures on "Fuel Economy in Relation to Hygiene," delivered by the author during the past year at the invitation of the Chadwick Trust. The subject is one on which very little definite experimental information is available, and on which the man in the street has very indistinct and, it is believed, very erroneous ideas. The transmission of heat into and out of matter is a subject particularly difficult to understand or to explain. We fully appreciate the author's efforts in this direction, and, on the whole, with one or two exceptions, he has succeeded in attaining his object. The blame for the continued use of inefficient heating appliances appears to be divided among the jerry builder, the tenant, and the makers of domestic heating apparatus, who in but few cases, according to the author, probably have no idea whether their manufactures are economical or the reverse, but in the case of the manufacturer, there appear to be extenuating circumstances, for Mr. Barker asserts that it would not be too much to say that if a manufacturer were to design the appliance with chief regard to the most economical principles it would be probably either so expensive or so inconvenient in use that it could not be sold to advantage. From such a remark one would naturally conclude that the art of domestic heating has reached practical finality. Perhaps the problem will be solved by pulverised fuel, which the author dismisses in three lines; nevertheless with an assertion that it will probably displace all other kinds of fuel, both for domestic and industrial purposes, though he does not mention its possibilities in the chapter devoted to probable future developments. We are inclined to agree there is a future for the application of pulverised fuel to industrial purposes, but it certainly requires some stretch of imagination to include the domestic hearth. In discussing heat in fuel, and explaining the fixed heat-content in each unit of electricity delivered to the consumer, Mr. Barker says that electric companies, if they lower the voltage, automatically give a proportionately greater amount of current at a reduced voltage. As a matter of fact, a reduction in voltage reduces the current, and without implying that the author has overlooked the point, we suggest that a more intelligible explanation would be that the reduced current-value consequent upon the falling voltage would be maintained during a longer period for unit consumption of electricity. Altogether the volume provides useful information, and is well worth careful reading.

FRENCH CORE BINDER.—The January issue of the "Fonderie Moderne" gives the following mixture for binding cores:—Pipeclay, 80 per cent.; destine, 20 per cent. This mixture should be passed through a fine sieve and sufficient water added to form a paste.

Hearth Sands.*

The refractory hearths and banks of the acid furnaces are made from pure silica-sands. An account of the physical characters and occurrences of numerous sands suitable for this purpose has recently been given by Professor P. G. H. Boswell in "British Resources of Refractory Sands for Furnace and Foundry Purposes," Part I., 1918.

Given a high silica-percentage, the main factor that determines the value of a sand for employment in steel furnaces is the shape and size of the component grains, and it is a well-established fact that in the sands used even-grading is an almost constant feature. The size of grain most usually employed would seem to be from 0.1 to 0.3 mm., but some variety in size and shape is permitted.

Even-grading, when not a feature of the natural sand, can be produced by screening or washing, and at the same time undesirable constituents, especially clay, can be partly eliminated.

The sands are mainly composed of sub-rounded fairly pure quartz-grains, which are answerable for the bulk of the silica found on analysis. Other constituents, which in the best sands form only a small percentage, consist of potash felspars, visible muscovite, ilmenite and magnetite. In British sands an unsatisfactory analysis is nearly always due to the presence of these substances.

In addition to the impurities present as distinct mineral grains, there often occurs a variable amount of interstitial clay-substance, including finely-divided micas, kaolin, and allied minerals. Further, the surfaces of the larger grains and the interstitial matter may be coated and stained by hydrated oxides of iron. The iron present may be reduced by washing out ferruginous clay-substances, but the coating and staining on the larger grains cannot be eliminated entirely.

The chemical analyses, quoted in Table I. from various trade sources, may be considered as representative of the sands in common use in this country. They show a silica-percentage ranging between such limits as 95 and 99 per cent., the average being about 98. A fall in the percentage is usually counter-balanced by an increase in the figures for alumina and water, pointing to the presence of an increased proportion of hydrated aluminium silicates.

The alumina, except in certain sands that contain a moderate proportion of detrital cyanite (aluminium silicate) or are highly felspathic, is usually present as interstitial clayey matter, and thus a rise in the percentage of alumina generally accompanies unequal grading. Felspar is indicated by increased percentages of alkalies and alumina, together with a relative diminution in the percentage of combined water.

tridymite and consequent knitting together of the hearth (Fig. 1) is greatly accelerated by the presence of iron oxide, and slag is sometimes added for this purpose before the first charge is made. In any case, as soon as the furnace is used the slag rapidly penetrates the porous newly-made hearth. It seems at first sight remarkable that, while the sand used is required to have a degree of purity not lower generally than from 96 to 98 per cent. of silica, the hearth itself in use contains only 70 per cent., even in the hottest layer. The "bank" above the surface of the bath has a higher percentage, and approximates in composi-

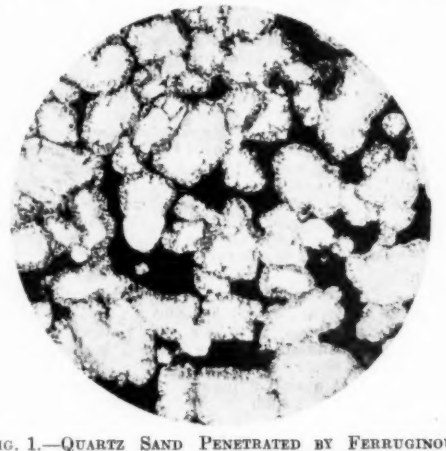

Fig. 1.—Quartz Sand Penetrated by Ferruginous Slag, Heated for 1½ Hrs. at 1,400 Deg. C. The Quartz Grains are Bordered by Fringes of Tridymite Magnified 30 Diams.

tion to the surface-layers of the brickwork, but is still much penetrated by iron oxide. The reason for this is that the surface-layer of the hearth requires repairs throughout the whole period of service; after each charge has been "tapped out" the hearth is examined, holes are filled with new sand, and the banks are repaired by throwing upon them sand that assumes a slope representing the angle of rest of the grains. It is an essential function of the sand to absorb the residue of slag left on the surface of the hearth and so prevent the formation of local patches deficient in

Table I.

	1	2	3	4	5	6	7	8	9	10
SiO_2	98.97	99.80	99.59	93.80	97.76	90.3	98.76	.974	99.85	98.26
TiO_2	.04	n.d.	n.d.	—	—	—	—	—	—	—
Al_2O_3	.46	.32	.25	3.30	1.64	.31	.64	.57	.02	1.39
Fe_2O_3	.02	.03	.21	trace	—	4.51	trace	.17	trace	.05
FeO	—	—	—	—	—	.21	—	—	—	—
CaO	.10	n.d.	n.d.	1.44	.15	1.02	.10	.14	.01	.26
MgO	.07	n.d.	n.d.	trace	.15	.15	.16	.10	—	.03
Alkalis	.08	none	n.d.	—	—	.23	.46	1.41	—	—
Water	none	none	n.d.	.96	—	2.22	.20	—	—	—
Loss on ignition ..	.34	.22	.27	—	—	.87	.25	.21	—	—
Total	100.08	100.37	100.32	99.50	99.70	99.84	100.57	100.00	99.88	99.99

1. Mold-washed.
2. Aylesbury, best quality.
3. Leighton-Buzzard washes.
4. Natural blown sand, Arden, Argyllshire.
5. Loch Libo Quarry, Caldwell (washed).
6. Hutton Cimbo moulding sand.
7. Typical Belgian sand.
8. Dutch sand, No. 1.
9. Fontainebleu sand.
10. Ground sandstone, Glenyards, near Greenhill.

Use of Sands in the Furnace.—Concerning the method of use of the sands, little detailed information is available, but it may be of interest to trace the changes they undergo during service and to compare them with the corresponding changes in other parts of the furnace.

The bottom is built up in successive layers upon the stepped brickwork of the furnace-structure. The first layers contain a large proportion of silica-rock; this is followed by layers containing more pure sand, which is banked against the side of the furnace to form the hearth itself in which the charge is to be melted. The total thickness may be 3 ft. These layers are "burnt in" successively, the temperature being raised until a sufficient degree of fritting has been attained. This is accompanied by the conversion of some of the quartz into tridymite and cristobalite. The conversion to silica, which would give rise to weakness during the next heat. To do this a sand free from slag-forming constituents is necessary, not only because these would occupy the pores into which the surface slag should penetrate, but because even a small proportion would seal the interstices and leave the new patch in a more or less impermeable condition. The patch, when successfully made, becomes a part of the hearth, and so it results that the average composition of an old furnace-bottom is that of a pure sand soaked with the residual slag.

The "Banks."—At the level of the surface of the melted charge, the sides of the hearth are in direct contact with the slag, and it is at this point, termed the "wash," that the "cutting" action of the slag is most strongly evidenced.

The "bank" above the "wash" is rather higher in silica-content than the bottom itself. It is exposed directly to the furnace gases and has a structure of

* Extract from the Special Reports of the Mineral Resources of Great Britain. Memoirs of the Geological Survey.

granular cristobalite with interstitial melt which is similar to that of the surface-layer of the brickwork. The requirements with respect to rigidity are much the same as for the brick itself when used in the "blocks," and it is evident that purity of sand is a necessity, though the presence of a considerable amount of alumina may be permissible. The main objection to alumina appears to be that in the presence of iron oxide it yields too fluid a slag; aluminous structures which may be perfectly refractory are therefore peculiarly subject to the "cutting" action of any slag or oxide present. Exact data for the comparison of the behaviour of various sands are lacking, but it appears that alumina is less active than other impurities in softening the bank.

The Furnace-bottom.—Below the "wash," where the metal is in direct contact with the hearth, the temperature is, of course, distinctly lower than that of the "bank." Nevertheless it necessarily approaches that of the melted steel, which may be as high as 1,600 deg. to 1,650 deg. C. at certain parts of the heat. This is well above the transition-point to cristobalite, and accordingly the surface-layer consists of rounded crystals of this mineral embedded in slag. The proportion of iron oxide is higher than that in the corresponding zone of the roof-brick, and it is indeed remarkable that sufficient rigidity can be obtained. This zone is apparently only 2 in. or 3 in. in thickness, a fact which suggests strongly that the layer of steel in contact with the hearth is not quite at the full temperature of the melt. Beyond the narrow cristobalite zone the hearth consists of interlacing crystals of tridymite, often twinned, and it is to this structure that its rigidity is mainly due. The analysis is remarkably similar to that of the black zone of a roof-brick. The interstices are filled with slag, but since the iron is reduced to a much greater degree than in the roof-brick, this crystallises as fayalite on cooling. Towards the exterior of the furnace the proportion of fused slag diminishes and fragments of unaltered ganister are found surrounded by fringes of tridymite. The slag may penetrate to the stepped brickwork on which the sand bottom is made. It is clear that in the lower part of the hearth little demand is made on the refractory character of the sand, but that impurities will in general have a weakening influence in that they contribute to the formation of slag. In spite of its loose texture the bottom frequently cracks when the furnace is cooling, and admits metallic iron or slag. In the latter case the tridymite crystals formed on cooling can be distinguished by their lath-shaped section, as in the roof-brick.

It is important to observe that throughout the interior of the hearth the iron is principally in the ferrous state. The metal that penetrates is, therefore, not rapidly oxidised, and is consequently less immediately harmful in its effect; in fact, the presence of solid metal in the colder parts might be regarded as a source of strength, but only so long as the iron does not become oxidised.

It will be understood from the foregoing sketch of the hearth-structure that the properties required in a hearth-sand are connected rather with the details of the manipulation of the sand than with the final composition of the hearth.

Mention has been made of the "angle of rest," which determines the slope of the sides of the bath. A high angle is important, and, other things being equal, an angular sand is preferable in this respect.

A property that is of the highest interest is the concentration of silica obtained in the fired refractory before slag-penetration occurs. In the case of roof-bricks, the durability of the brick under a constant attack by slagging is determined by the mass of silica that must be removed before the brick becomes too thin. In the hearth, wear does not take place to the same extent, but since the strength of the hearth is dependent on the proportion of free tridymite at furnace-temperature, a similar consideration will apply. In the presence of only 70 per cent. of silica there is little margin for any decrease in the silica-content. This is dependent upon the porosity of the newly-made hearth or patch, for the amount of slag that penetrates is the amount required to fill the pores. Clearly it is essential that the sand should be of such a character that it will pack as closely as possible when thrown upon the hearth. Great differences in porosity can be produced by suitable grading, but these differences are only fully developed when the sand is "shaken down." No such action is possible in the furnace, and for this reason the good effect that might be hoped for from the use of a mixed grading is largely nullified. It will readily be seen that the presence of a small amount of fine material in a coarse sand might actually increase the porosity of the sand before shaking, on account of the separation of the grains by the fine particles, and it is of interest to note that the sands which have proved satisfactory are those that have a uniform grade and attain their full density without being "shaken down."

It is doubtful whether any good purpose would be served by increasing the proportion of the silica in the hearth, as might be done if a closer packing could be produced in the sand. The quantity of slag to be absorbed seems to balance well with the porosity of the sand used for repairing after each heat, and it seems probable that any disturbance of this relation would lead to the formation of fluid patches that would be a source of trouble during the subsequent heat.

A Moulding Box Speciality.

Messrs. A. Warden & Company, 44, Shepherdess Walk, City Road, London, have developed a speciality in corrugated pressed steel moulding boxes. The flasks are capable of being packed at each end, additionally to the usual top and bottom parting. Each part is fitted with bars to the shape of the pattern, which

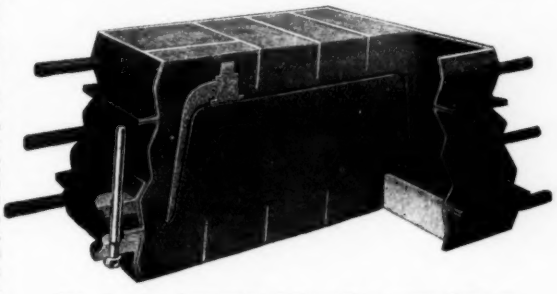

FIG. 1.—AN ASSEMBLED 3-PART BOX WITH CORE IN POSITION.

allows of the sand being supported quite close to the casting face. The accompanying figure shows a section of a three-part box, assembled and rammed with sand, and with the core fixed in position for moulding kitchen sinks. The standard sizes of these flasks range from 10 in. square and 3 in. deep to 18 in. and 27 in. and 5 in. deep.

ELECTRIC FURNACES FOR HEAT-TREATING.—The Electric Furnace Company, Alliance, Ohio, is installing a completely automatic heat-treating set at the new plant of the C. H. Wills Company of Marysville, Mich. The set is designed to treat all kinds of automobile parts, and consists of a 200-kw. hardening furnace, with a motor-operated quenching arrangement and a 200-kw. drawing furnace.

A NEW SOLDER.—A soldering composition that is useful for patching holes in castings has been patented by F. E. Lampe. The number of the American patent is 1,327,620. The composition follows:—Powdered solder, 40 lbs.; resin, 8 lbs.; sal ammoniac, 4 lbs.; light petroleum, 4½ lbs.; dark petroleum, 2½ lbs.; ceresin wax, 12 ozs. The solder thus carries its own flux and is used by being simply melted on to the surface to be repaired.

THE SOUTH AFRICAN MOULDERS' UNION.—The Ironmoulders' Society of South Africa has decided to rejoin the South African Industrial Federation. The significance of this lies in the possibility of the creation of a joint board in the engineering trade, a thing which has been impossible owing to two of the unions in the trade being members of the Federation, and the ironmoulders being out of it. This, from the Union point of view, being regarded as a source of weakness. Now that all three engineering unions are members of the Federation, it is expected a joint board in the industry will be instituted at an early date.

GERMAN FOUNDRY TRADE.—The Association of Iron Foundries, reporting on the general situation, states that many works which produce commercial castings are only able to keep in full operation by partly working for stock, especially as customers expect a further reduction in prices, which are already depressed. During the past quarter material restrictions in working were only obviated by the receipt of orders for foreign account. In machine castings no improvement in the situation is reported, either from the Northern or the Central foundries; most works are operating on a reduced output and a very small stock of orders. The foundries in the West announce a complete state of stagnation in activity; orders are scarce and mutual competition is perceptible. Complaints are made in this district of an inadequate and defective supply of raw materials, particularly in the case of foundry coke and of pig-iron of an unsatisfactory quality

Mechanical Tests for Cast Iron—Part I.*

By F. G. Cook.

The subject of mechanical tests for cast iron may be conveniently divided into two sections, *i.e.*, the tests usually called for by engineers' specifications and those adopted as a guide to efficient working in the foundry.

An examination of the tests usually included in engineers' specifications reveals the fact that they are so carelessly framed as to be of no practical value. Take, for instance, the usual Admiralty specification, which reads as follows:—"Test pieces are to be taken from such castings as may be considered necessary by the inspector. The minimum tensile strength is to be 11 tons per square inch taken on a length of not less than 2 inches"—for many years the test required was 9 tons per square inch, but of late, for reasons the author has never seen stated, the required breaking load has been increased to 11 tons per square inch.

What was in the minds of the framers of this specification is not an easy matter to make out. Is the test bar expected to represent and prove the tensile strength of a casting? If so—seeing that the specification is the same, whether the casting in question be a small cylinder, say for a torpedo boat destroyer electric-lighting set, whose average thickness may be ¼ in., and weight, not many pounds, or a flywheel, say of 25 tons weight—it leaves much to be desired. Also as initial strains due to design, etc., and rate of cooling have such a marked effect upon the strength of these relative castings, and that they may both be cast with a metal whose composition is quite unsuitable for either of them, but which would produce a test-bar which would fulfil the requirements of the specification, it is obvious that it fails to have the desired effect. If this is not the result sought, is it thought to prove the strength of the metal cast in a particular manner? If so it is equally useless, as owing to the absence of any specific rule as to the position, size and gating of the test-bar, very widely different results can be obtained with bars cast on the same casting as has been shown by Buchanan.

The tests called for by specifications are generally mechanical, but occasionally they are chemical; for instance, in a specification issued some time ago, for a 13-horse-power high-speed engine, the only reference to the quality of the iron to be employed was that "no cast iron used in the engine should contain more than 0.5 per cent. of phosphorus." A notable firm in sending in their quotation pointed out that this quantity of phosphorus was not in accordance with their usual practice, but they were willing to substitute for it any reasonable mechanical tests. The engineer, however, was adamant, and so the order went past them.

The American specifications for grey iron castings are as follows:—The quality of the iron going into castings under specification shall be determined by means of the "Arbitration bar"; this is a bar 1¼ in. diam. by 15 in. long, which shall serve the purpose for both tensile and transverse tests. The bottom of the bars is 1-16 less in diameter than the top, to allow for draft and for the strain in pouring. Two bars are to be cast in one mould, which is to be rammed up with green sand a little damper than usual, well mixed and put through a No. 8 sieve, with a mixture of 1 to 12 of bituminous facing; the mould to be rammed evenly and fairly hard, thoroughly dried, and not cast until cold. The test-bars are not to be removed until cold enough to be handled. Two sets of bars to be cast from each heat: one set from the first and the other from the last iron going into the castings. When the heat exceeds 20 tons, an additional set of two bars shall be cast for each 20 tons or fraction thereof above this amount. In case of a change of mixture during the heat, one set of two bars shall be cast for every mixture other than the regular one. Each set of two bars to be made in one mould. The bars shall not be rumbled, or otherwise treated, being simply brushed before testing. The bars are tested first transversely, upon which the Americans mostly rely, and the tensile test-bar is made from one of the broken halves, turned down in the centre to 0.8 diameter, which must give tensile test results of not less than—

8.0	tons per sq. inch	for	light castings.
9.3	,,	,,	medium ,,
10.7	,,	,,	heavy ,,

In dividing castings into light, medium and heavy classes, the following standards have been adopted. Castings having any section less than ½ in. shall be known as light; castings in which no section is less than 2 in. thick shall be known as heavy; whilst medium castings are those coming in between these two classifications. Although one may not agree with everything recommended, yet the Americans are entitled to much credit for the definite way in which the rules have been framed, which at least insures that tests carried out under this specification are strictly comparative, a condition greatly to be desired.

Referring to the Engineering Standards Committee, the author pointed out that in the pan-head type no attempt has been made to provide for the sudden change of section involving the crystallation of the metal at sharp angles in lines of weakness. The head should have a larger bearing surface so that a more easy radius may be used in the corner, and so leave the strength at this portion less impaired. The underside also should be slightly bevelled to insure the strain coming close up to the neck. In any case, pan-headed bars are not desirable for cast iron. The screwed bars are obviously unsuitable for cast iron, as the bottom of the thread is too small in comparison with the area required to be ruptured.

Test-bars which are designed with corrugations with a pitch of 3-16 in. and a depth of 3-32 in, which, with grips made to suit, are admirable both for the life of grips and a fair pull on the bar, and are very convenient for rough tests on unmachined bars.

Obviously, the benefits derived from a regular series of tests intelligently carried out result not only in greater confidence in what one is doing, but leads often to much more economical working.

The great cost required to install a hydraulic tensile machine, with its foundation, accumulator and pumps, with proper house to accommodate them, has militated against a wider application of testing in the foundry.

It is not the author's intention to deal with the various types of testing machines, but one, the invention of Mr. George Beaufort Richards, of Wednesbury, which largely eliminates the difficulty of first cost of installing, has already been described in these columns.

High tensile and transverse test results are only obtained by careful attention to the chemical and physical properties of the metal, but as the latter were recently dealt with by the author, it will only be necessary to deal, in a general way, with the former.

Carbon.—The most important element in cast iron is carbon. The whole physical properties of the metal depend upon the quantity and condition of this element, the value of the other elements being in accordance with the effect they have on the carbon and the condition in which it exists. It is very seldom that any *particular* mention is found of the *total* quantity of carbon present, whilst the necessary quantity of combined carbon is frequently referred to, yet obviously, with the same percentage of combined carbon present, there must be a great difference in the condition of the metal if the total carbon differs from, say, 3 to 3.75 per cent. Dr. Stead* has shown examples where an increase of each 0.1 per cent. of graphite has reduced transverse strength by 2 cwts. and tensile strength by 0.8 tons per square inch.

* Paper read before the London Branch of the Institution of British Foundrymen, Nov. 18, 1920.

* British Foundrymen's Proceedings, 1915.

Prof. Turner, in his admirable book, "The Metallurgy of Iron" (p. 251), states that maximum tensile strength is associated with 0.47 per cent. of combined carbon and maximum transverse strength with 0.70 per cent. The author's experience, however, leads him to the conclusion that these figures for present-day practice should be reversed, maximum tensile strength being obtained with 0.6 to 0.8 per cent. and maximum transverse with 0.4 to 0.6 per cent. and with total carbon not exceeding 3.25 per cent.

Silicon.—One of the most important elements in determining the suitability of cast iron for any given purpose is silicon. This element is always present, in proportions most variable, whilst the influence it exerts on the condition of the carbon present and consequently on the hardness and fluidity of the metal is most marked. Prof. Turner's research on the effects of this element on cast iron, though made some 30 years or so ago, has stood the test of time, and probably laid the foundation for the application of chemistry to practical working in cast iron.

As the quantity and condition of the carbon has been stated to be so important, and that the effect of silicon on this element is so marked, if a formula can be adduced that will show when these two elements are in the best proportions for any given class of work, a very important stage will have been reached. With this object in view the author has used with marked success in practical working a more or less empirical formula, which is:—

$$SC = \frac{C}{4{\cdot}26 - \frac{Sil}{3{\cdot}6}}$$

Where SC = the equilibrium between silicon and carbon.
C = *total* carbon in percentage.
Sil = silicon in percentage.

The elements carbon and silicon are in the best proportion when the value of SC is as given below:—

For ordinary work such as pans, grates, easily machined casting and pipes	= SC should	= 0.9 to 1
Locomotive cylinder (maximum transverse strength) ...	,,	= 0.83
Steam, gas, Diesel and hydraulic cylinders (maximum tensile strength)	,,	= 0.76 to 0.82
Chilled castings.....	,,	= 0.75 to 0.8
Acid resisting	,,	= 0.85

Sulphur.—By many, sulphur is looked upon as the arch enemy of the ironfounder, but although its presence makes the molten metal thick and sluggish, giving rise to blowholes, yet this element in fair proportions, say 0.12 per cent., adds considerably to the wearing properties and strength of the metal. In every case, however, sulphury iron *must* be cast as hot as possible if trouble is to be avoided.

Phosphorous has been wrongly regarded by many who think it is impossible to produce strong irons without this element being very low. To lower this element they frequently resort to hematites, which, with their high percentage of total carbon, often do more harm than would be done by a liberal amount of phosphorus. When the proportions of total carbon and silicon are in accordance with the above formula as regards maximum tensile strength the percentage of phosphorus may be as high as 1 per cent. without seriously jeopardising the tensile strength; in fact, with cylinders and castings requiring maximum strength and when of complicated design, the reduction of shrinkage and additional fluidity of the metal due to this percentage will generally result in a sounder casting with less initial contraction strains.

Manganese has a tendency to harden the iron both directly and by causing the carbon to remain in the combined form; in the presence of much sulphur, however, it may act as a softener, by uniting with that element, forming manganese sulphide, which rises to the top of the metal in the ladle, and passes away with the slag. When the metal does not remain long enough in the ladle, or is not hot enough for this to take place quickly, the manganese sulphide will be found on the top part of the casting in the form of hard spots, which are difficult to machine. The general properties of the metal are not materially affected so long as this element is not in greater proportions than 0.7 per cent. For castings in which denseners are employed it is not advisable to have more than 0.4 per cent., otherwise there will be a tendency to chilling. By removing sulphur, and by forming brittle, spiky crystals, which break off under rubbing, much of this element is not good for castings which require good wearing properties. The figures for the various constituents given above are those the author considers desirable to produce maximum tensile strength on a bar cast 1¼ in. diameter turned down to a ½ square inch area. The effect of rate of cooling would require to be considered when fixing the percentages for castings whose thickness is more or less than those stated.

The important tests which are of use as a guide to foundrymen are:—

(1) Keep's tests, shrinkage, deflection and transverse; (2) hardness test; (3) casting temperature or fluidity test; (4) measurement of volume and pressure of cupola blast; (5) impact test.

Keep's Test consists of casting ½ in. square bars between iron yokes, the ends of which are 12 in. apart. When the bars have cooled down the shrinkage is shown by the difference between the length of the bars and the gap in the yoke in which they were cast; this is usually measured by inserting a taper graduated wedge in the gap and measuring off the dimension of the space. This operation necessitates the bringing of the pattern plate yokes and bars into the office for measurement or vice-versa. To obviate this Mr. Broughall, of Messrs. Alfred Herbert, Limited, has designed a micrometer on which the bars can be measured direct without application to the yokes and wedge. This necessitates the yokes being machined to a dead length and a daily trial made of the yokes with a point gauge 0.003 in. oversize, the yokes being discarded when the point gauge will enter, which is quite a rare occurrence.

It has been thought by some that the skrinkage figure is a direct measurement of the amount of silicon present, but as there are other items which appreciably affect shrinkage, it is obviously only a partial guide as to the silicon content.

The shrinkage test is quite a comparative one, and when the amount of shrinkage which is associated with the most satisfactory castings has been obtained any deviation can be rectified by a little addition or diminution of silicon if the shrinkage becomes too high or low.

A very useful method to adopt is to record the daily results in the form of a graph, with a base line at the desired amount of shrinkage. This, if set out on a conveniently large scale, gives a very good impression of the way in which the metal is tending.

Although, as stated above, shrinkage cannot be relied upon to give a definite determination of the silicon content of the metal, under normal conditions a shrinkage of 0.183 in. = 1 per cent. silicon, and, to take the other extreme, 3.5 per cent. silicon is associated with 0.123 in. shrinkage. It is surprising with low silicon irons, where one is sailing near the wind as to machinability, what a great amount of change is expressed by a variation of 0.008 in. Obviously, to obtain the best results, the test requires not only carefully taking, but intelligently diagnosing.

A good impression, not only of the chilling quality of the iron, but of the way in which it backs off into the grey, is obtained by splitting the ends of the bars which have been cast adjacent to the yokes.

The full benefit of this test is obtained, however, by testing the bars for deflection and transverse breaking load. The most important point to be watched in connection with the transverse test is the deflection obtained, which is often of more importance as a guide to the quality of the metal than the ultimate breaking load. Unfortunately, the machines usually employed for this test are rarely fitted with any apparatus that will give a reliable result, owing to their leaving no permanent record after the bar is broken. A machine,

designed by Keep for use with the ½ in. square bars previously described, is fitted with a mechanism which, giving a permanent diagram to a scale of five times the actual deflection, meets all requirements.

The following table gives average particulars of shrinkage, deflection and breaking load obtained with various classes of iron:—

Class of Material.	Shrinkage.	Deflection.	Breaking load.
	in.	in.	lbs.
Tough strong iron ...	0.160	0.25	550
Hard strong iron ...	0.168	0.22	630
Soft iron	0.123	0.18	423
Mottled iron	0.207	0.11	375
White iron	0.226	0.08	250

from which it will be seen that to obtain a big deflection, strong irons are necessary, whereas many believe that greatest deflection can be obtained with soft irons.

The greatest breaking load on ½ in. square bar with American irons recorded in Keep's book, "Cast Iron," is one of 450 lbs., and in some correspondence the author had with him he said that a breaking load of more than 430 lbs. on this size bar was not to be expected. It will be noted that the above table gives breaking loads of 630 lbs.; in fact, results showing over 700 lbs. have regularly been obtained, a proof, the author takes it, of the superiority of British irons over American.

Hardness.—Although most people have a more or less definite idea as to the relative terms of hardness and softness, yet it remains a fact that science has so far not succeeded in formulating a satisfactory definition of the term hardness. The methods devised for determining this quality are as varied as the expressed opinions as to what is hardness and what causes it. For instance, Dr. Unwin considers hardness to be the resistance a material opposes to penetration by another body. Dr. A. E. Hutton defines it as the resistance offered by a smooth surface of a solid substance to abrasion by a sharp fragment of another substance of slightly greater hardness. Sir Robert Hadfield considers it to be simply resistance to deformation, and holds, therefore, that to measure it in a metal, one has only to measure the yield point; also, according to many, hardness in a metal is identical with its resistance to wear, and however true this may be of other metals, such as case-hardened steel pins, etc., it is not *necessarily* true in the case of cast-iron for steam, gas and oil engine cylinders, the essential feature in successful metal of this class being its ability to take up a high polish quickly when at work; and this is not to be obtained by any relative degree of hardness.

The methods usually adopted for determining hardness in practical working are the drill test, Brinell indentation machine, the Scleroscope or Rebondimeter, and Professor Turner's scratch test.

(To be continued.)

MAGNESIUM IN THE FOUNDRY.—Magnesium, as sticks or rods, is used to deoxidise other metals in foundries, and is a constituent of alloys. More magnesium is now used as a deoxidiser or scavenger in metallurgy than for any other purpose, but its employment in alloys is increasing, and may eventually become important. An alloy of magnesium and aluminium is used in making castings for aircraft engines and parts of aeroplanes. The skeleton of the British airship R34, the first dirigible to cross the Atlantic, is an alloy of aluminium and magnesium.

THE RETURN OF PHOSPHORUS TO BASIC STEEL.—Mr. Henry D. Hibbard, writing in a recent issue of the "Blast Furnace and Steel Plant" on the subject of the reversion of phosphorus from basic slag to the steel in the ladle, states:—Excessively strong reducing conditions, as, for instance, the presence in the metal of 0.5 per cent. silicon or high carbon or manganese with high temperature for a protracted period of time will reduce phosphorus freely from the slag, even though there is no increase in its silica content. In making steel in the electric furnace if complete desulphurisation is aimed at nearly all of the phosphorus in the remainder of the dephosphorising slag left in the furnace after skimming will be reduced and re-enter the metal even though the silica in the slag does not exceed 20 per cent.

Moulding an Annealing Barrel on End.*

The following deals with a moulding proposition in which the production of a casting for the rotary annealing barrel shown in Fig. 1 is involved. The casting contains no openings at either end, but has an opening, 5 by 24 in., at the side for charging the barrel. As first planned the pattern was made split through the centre, to be moulded on its side. For the production of the body core a skeleton core-box was furnished. This method of moulding was deemed inefficient by the foreman of the foundry, with the result that the problem was handled in a radically different way.

The pattern was made solid so as to mould it on end, and the skeleton core-box was changed to a regular half core-box. The assembled core weighed 575 lbs., and in moulding the pattern had to be supported on

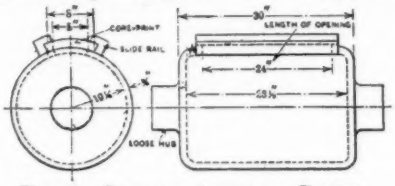

FIG. 1.—SHOWING ANNEALING BARREL.

four chaplets, which are shown in Fig. 2, resting on the slab cores F. These cores were rammed in the bottom of the mould directly under and next to the pattern. The thickness of the walls of the barrel was ¾ in., so that by using three wooden strips of this thickness the core was centred in the mould. The core was held down and secured at the top by means of the four chaplets G, which press down on the core, their stems passing up through the cope and against a wooden cross-bar secured to the cope flask. An air vent was made consisting of two vertical channels B, which were connected by a cross-channel C located near the top of the core. This cross-channel continued on out through the core E, thence into the moulding

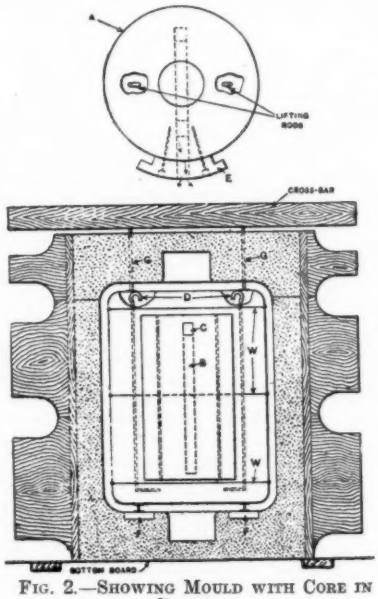

FIG. 2.—SHOWING MOULD WITH CORE IN POSITION.

sand and up to the top of the mould. The slab core E, provided for the charging door in the side of the casting, was fastened to the body core A by five 20-penny nails. In using nails to hold this core to the body core it was necessary to drill holes in the cores. Five holes were drilled with a piece of core wire through the slab core, these holes being used to locate those in the body core. The slab core was then pasted in position and nailed securely in place. The two half-cores, after being pasted together, were reinforced by three binding wires W. Two lifting rods D were provided in the heavy core for lifting it from the mould.

The advantage gained by moulding this pattern by the method just described is that only 2½ hours is required to make the core with the half core-box, whereas four hours was required when using the skeleton core-box. In addition to this, the core made from a skeleton box is not as satisfactory as when made in a regular half core-box.

*From the "Canadian Foundryman."

Institution of British Foundrymen.

COVENTRY AND DISTRICT BRANCH.

At a meeting of Coventry Branch held on December 8 Papers were read on "Production of an Oven Roll in Green Sand," by MR. R. PRICKETT; and on "Pattern Plates," by MR. J. E. BATES.

MR. F. H. HURREN, A.I.C., Branch-President, said that they were very fortunate in having two Papers, both by practical men. The Papers were on widely different subjects, one dealing with heavy castings and the other more particularly with light castings.

The Manufacture of Pattern Plates.

Pattern plates and their production for modern foundry practice is a subject that is in great need of further study. There is a shortage of pattern plate moulders, that is, skilled moulders, who have

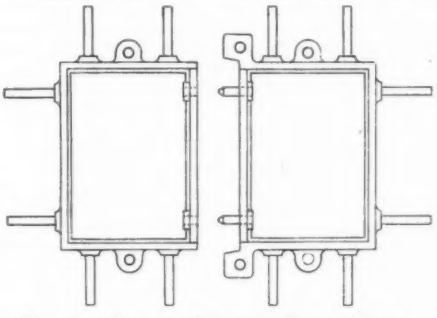

FIG. 1.—PLAN OF PATTERN PLATE MOULDING BOXES.

devoted considerable time and thought to the matter.

Pattern plates are usually made of a metal that is easy to dress and finish. Some are made of brass, some of cast-iron, but the majority are made of "pattern metal," composed of 85 per cent. lead, 10 per cent. antimony and 5 per cent. tin, or similar mixtures.

There are three kinds of plates that will be referred to as briefly as possible. These will be called:—(1) Double-sided plate, (2) transfer plate, (3) interchangeable composite plate.

Obviously, a description of the double-sided plate would be traversing common knowledge. It will be sufficient, therefore, to say that a double-sided plate is one in which one half of the pattern is on one side and the other half on the reverse, so that when the two half-moulds are made and brought together a complete mould is made.

The method of making this double-sided plate, except that more care is used, is the same as any ordinary mould. The tackle used is usually very heavy and cumbersome, the moulding box

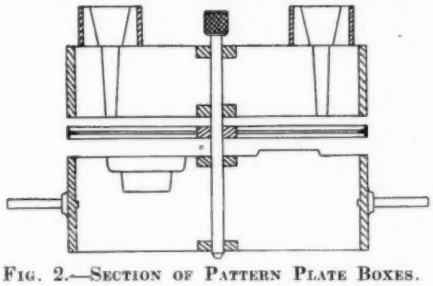

FIG. 2.—SECTION OF PATTERN PLATE BOXES.

being very much larger than the size of plate to be made. The frame, which is sandwiched in between the moulds to receive the pattern metal and give the required thickness to the plate, very often becomes warped.

The tackle used for a pattern plate for a 14 in. × 11 in. moulding box when rammed up with sand weighed 4 cwt. 26 lbs, was replaced at the author's works by tackle giving a rammed-up weight of 2 qrs. 18 lbs., a reduction in weight of over 80 per cent.

The average pattern plate costs over £4 in labour costs alone to produce before it is ready for the machine. Such a cost makes one hesitate to make plates except for very large orders.

The fact was recognised that some plates can only be made upon the double-sided principle, but the majority of plates can be made on the transfer method.

By the transfer principle a plate is produced that gives two castings for every single pattern used. This, as will be readily seen, reduces the cost of the pattern plate by 50 per cent. for patterns alone. To make this type of plate a special pair of boxes is used, together with a frame which has been previously drilled to the same centres as the moulding boxes for which the plate is to be used. (See Figs. 1 and 2.)

The advantage of using this principle of making top and bottom moulds, eliminating the turning over of the plate, is specially pronounced in sum-

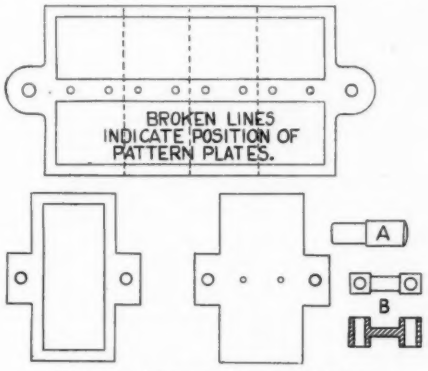

FIG. 3.—PLAN OF PATTERN PLATE.

mer, when the moulds are exposed to the heat of the shop, causing the edges to crumble away, with the consequent producing of dirty castings.

In most foundries there is on the moulding machine a gas ring, used to take off the cold air from the pattern plate. Through the machine operator forgetting that the gas is alight, many valuable plates have been damaged, but this does not occur if the transfer system is adopted.

In connection with plate production an adaptation of the principle becomes very helpful when the moulding boxes are oblong in shape.

It will readily be seen that the square type of box is the most suitable for the transfer system. When, however, the oblong box is used, say 18 in. × 11 in. or 14 in. × 11 in., which are the two sizes most frequently used at the Coventry Malleable Foundry, the area is restricted to the half width of the box, that is, 5½ in., when the plate is to be made.

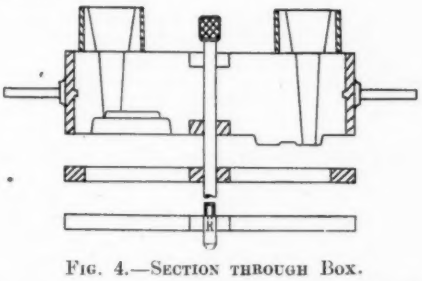

FIG. 4.—SECTION THROUGH BOX.

It can be demonstrated, however, that a transfer plate can be made and yet have the half of the box, that is, 9 in., an increase of 3½ in. for transferring purposes.

Assuming a plate is to be made for the 18 in. × 11 in. boxes, a well-fitting box is chosen; when the odd size is made, the exact centre line is marked between the box pinholes, the patterns arranged on one side of this line, the mould made and finished as usual.

When the frame is made as just indicated it is placed on the bottom half of the mould, which is then closed with an ordinary flat mould, and what is actually a half-plate is cast. When the mould

* Paper read before the Coventry Branch of the Institution of British Foundrymen.

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is sufficiently cooled, the sand is removed from the frame and there is then a frame, half filled with pattern-metal, giving the impression of the bottom mould. The operation is repeated in respect to the second half of the mould, which is the top mould, making the complete transfer plate.

When the pattern plate has been filed and finished, the moulder should observe the following procedure:—

(1) The bottom mould is made and the cores placed in position.

(2) The top mould is then made, but on closing the box must be put on the wrong way round. If this is done the resulting castings will show a perfect joint.

An interchangeable composite plate can be made on the double-side or the transfer system, and

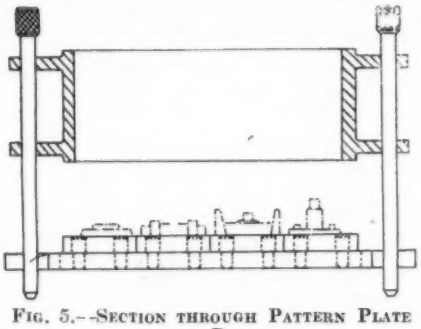

FIG. 5.—SECTION THROUGH PATTERN PLATE AND BOX.

eliminates the necessity of making duplicate patterns. In this system a plate is made up of two, three or more sections, all of which are interchangeable. When all these sections are located together and placed alongside each other, they form one complete plate.

A plate suitable for the standard 14×11 box, with ⅜ in. box pins, is shown in Figs. 3, 4 and 5.

The question of finish is largely determined by the ability of the moulder, the facing sand used, the temperature of the metal, the hardness to which the mould has been rammed, the mould dressing, and the humidity of the sand. All these points are worthy of much attention.

The sand recommended was two measures (each consisting of 6 cu. in.) of red sand and one of black sand, both being previously well dried. One pint of plumbago, ½ pint asbestos powder, and finally 2½ pints of water are added. The water, however, may be replaced by 3½ pints of paraffin. This mixture is then well ground.

The mould is then made and finished. Before closing and casting, the mould is dusted with asbestos powder, the excess of which is blown off with bellows, and it is then finally dusted with plumbago. A plate should thus be produced requiring a minimum of pattern filing.

The casting temperature of the metal has a great effect on the skin of the pattern plate. For ascertaining a suitable temperature, the generally accepted rule is the "paper method," *i.e.*, just letting the metal be sufficiently hot to scorch paper. The better method is undoubtedly by the use of thermometer or pyrometer, the most suitable temperature being 300-310 deg. Centigrade.

DISCUSSION ON EXPERIMENTS IN MALLEABLE IRON.*

PROFESSOR T. TURNER, who proposed a vote of thanks, said Mr. Hurren had given them a paper which was so plainly delivered and so well illustrated that they were able to follow it better than they would otherwise, because it was usually very difficult to follow a lecture which dealt so largely with engineering results. He was inclined to differ a little from Mr. Hurren as to the statement that perhaps no branch of metallurgy had received so little attention during the past century as had been given to malleable castings. If, however, what was meant was "particularly in this country," it was probably true. A good deal of attention had been given to the subject during the last few years, as the paper illustrated, but if they went back ten or fifteen years in this country they might have searched in vain for work in which the Brinell or other tests, such as pyrometer tests and analysis, had been brought in to aid discovery. In America there had been an enormous change in connection with malleable cast iron during the last ten years or so. The policy of secrecy had been given up, and investigators and manufacturers had freely contributed information for the general good. New standards had been adopted, in reference, for instance, to yield point, maximum stress, and elongation, and every manufacturer was expected to work up to figures which it was known could be readily obtained. Those figures, which were very much higher than even American manufacturers were willing to guarantee ten or fifteen years ago, were very largely given in a series of papers in the Journal of the American Foundrymen's Association. Probably twelve or fifteen papers bearing on the subject had appeared within the last six or eight years, and anyone who was interested in "black-heart" iron, and wanted to know the standard that could be reached with it, might very well consult those papers. He did not think that there was very much in Mr. Hurren's paper calling for criticism. It was clear that Mr. Hurren, in his experiments, had before him certain objects which he desired to obtain. But there must be a great many other questions, besides those which Mr. Hurren had dealt with, which would be interesting to many men connected with the trade, and no doubt by pooling their experience manufacturers would be able to help each other. It was quite a mistake to suppose that one man could get all the information and all the tricks of the trade and keep them permanently against his competitors. One man might say that he depended for his success upon the annealing, whilst another might depend upon a certain grade of iron. The latter, however, might not be able to get the iron he preferred. If a man was only in the habit of following a particular receipt, according to which he might, say, throw in so much scrap, and he did not know what that scrap was, then it was only by good fortune that he could get uniform results. To one question asked in the paper he might try to give an answer, though possibly it might be the wrong answer. Reference was made in the paper to the increased elimination of carbon on long annealing of the specimens to which steel had been added. It was shown that, with longer annealing than was usual, the carbon was lost in greater proportion. Now he noticed that the silicon was high where the carbon was lower, and perhaps that was because silicon tended to eliminate carbon. If they wished to have a comparative experiment in respect of time they must also have the silicon uniform. He was inclined to think that that was the explanation in the case mentioned. He was interested to see the results of lowering the annealing temperature and raising it again. It appeared that varying the temperature in this way resulted in more rapid annealing. That was not what one would expect at first sight, the general belief being that the more uniform the temperature was kept the more steady would be the effect in relation to carbide of iron. Mr. Hurren's experience, however, was not a new one; it had been mentioned several times in the American researches to which the speaker had referred that quicker results could be gained by raising the temperature and lowering it again. That, of course, must be done in an orderly manner, deliberately, and it might be that it would be possible to save fuel and to quicken the process of annealing by making these changes of temperature.

MR. H. L. REASON, in seconding the vote of thanks, said he was very much interested in Mr. Hurren's remark as to his inability to obtain much useful information from published literature, which confirms his own experience. With reference to the Cast Iron Research Association, he (Mr. Reason) was quite sure when the Association was in full working order immense benefits would be available for the trade. Manufacturers would pool their knowledge, which would be for the benefit of all, and collected data would always be available for the members. Mr. Reason said he could only speak as a user, and it would be a great relief to him to know where he could obtain malleable iron castings with good machining qualities. When large repetition lines could be ordered he believed it was possible to get some satisfaction

* See page 125.

in this direction, but for quantities of medium weight—castings up to a gross—the results, as a rule, were disappointing.

MR. F. J. COOK said he could quite confirm what the lecturer had said about the secretiveness of the trade. This was very much to be regretted, and, although it was being broken down, it was being broken down very slowly. They hoped that when the Cast Iron Research Association got properly to work they would break it down much more quickly. The lecturer's remarks about the advantage of 0.6 per cent. silicon quite agreed with the speaker's own observations. This was a very advantageous percentage in the case of malleable iron. The figures showing similar results from different parts of the same oven proved that the ovens Mr. Hurren used were very evenly heated. This was not always the case, but ovens were now being devised which allowed of much easier temperature control. The observations with regard to the behaviour of carbon in the different thicknesses of castings were interesting. They were told that there was no greatly increased loss of carbon in any of the series, though one would have expected that the thin section would have been more readily heated, would have felt the effect of the fire heat more than the thicker ones, and thus would have lost more carbon. That seemed to bring out a point which the speaker thought was by most people not properly understood—namely, that the structure of the iron, or the fracture of the iron, was more important for obtaining good results than was the analysis. One might have two samples of malleable iron giving the same analysis, and yet one would give a white and the other a grey fracture with corresponding tests. In order to get good physical properties, iron with a good white fracture should be used, and this casting would have a whiter fracture than the other and would therefore withstand a higher temperature on annealing. The point mentioned by Mr. Hurren as to the raising and lowering of the temperature during annealing having no detrimental effect on the iron was very interesting, and had been referred to by many others. It had been noted that by certain variations of temperature during annealing, and particularly when the temperature was initially made very high and afterwards reduced, better results were obtained than by the uniform maintenance of a lower temperature. It seemed to him that when once the breaking down of the carbon had got a good start it continued very much more quickly, even though the temperature was afterwards lowered.

MR. A. MATTHEWS said he could quite agree with the remarks of Professor Turner in regard to the silicon having the effect of reducing the combined carbon. He thought that in Table 3 the manganese was given as 0.13 per cent., as against 0.14 per cent. in the other cases. Manganese, as they all knew, had the effect of producing hot castings, but the lower the manganese the more easily was the combined carbon changed into graphitic carbon. He asked what type of annealing oven was used for these samples. In reference to the temperature of the oven, he presumed that the heat was not rushed up with any particular speed—probably it was thirty or forty hours to bring the oven up to its highest temperature. Rapidly heating the oven was often the cause of the inferior machining properties of malleable castings. No doubt Mr. Reason had often found that malleable castings had a skin which would completely peel off. To his own mind, that was due to two things: (1) to the oven having its temperature raised too quickly; (2) high manganese content prevented the silicon being changed to a silicide of iron, thus forming a skin.

MR. REASON explained that his trouble had not been so much the skin as hard parts (bits about as big as a pin's head) in the castings.

MR. MATTHEWS could quite understand the temperature being brought up to 1,000 deg. C. and then lowered, but he thought that if it were allowed to fall below 900 deg. C. trouble would result, and the annealing greatly retarded.

MR. J. WESTWOOD said he would like the lecturer to tell them what kind of iron he generally used, whether the steel employed was hard or soft, and whether the ovens were fired with coal or gas. He thought the firing made a little difference. Information about malleable iron was kept back as if there was some mystery about it. He did not think that there was any secret about the making of malleable iron castings; all that was required was common sense and a little metallurgical knowledge. The amount of free carbon shown in his tables hardly agreed with the speaker's experience. He had always found that, comparatively, the more combined carbon present the better the results. A Government inspector once remarked to the speaker that it was impossible to make malleable iron from cupola metal. The inspector, however, changed his view when the test-bars gave a tensile strength of 22 tons, an elongation of 5 per cent., and a bending over a 1-in. pipe of 180 deg. without fracture. He wished to know whether the lecturer had carried out experiments to ascertain if any difference was caused by heat-treating the castings before annealing. Sometimes it was necessary to stove castings to keep them from "flying" before annealing, whether it assisted the annealing or not. Another matter referred to was the raising of the oven to a very high temperature, say 950 deg. or 1,000 deg. C., and then reducing it, and finally raising it. Similar, but rough, experiments carried out by the speaker did not confirm the author's results. He would like to ask the lecturer whether the cupola used in his experiments was a plain one, provided with tuyeres, one on each side blowing directly into the cupola, or was there a blast belt.

MR. H. FIELD thought that the earlier and the later remarks of Mr. Westwood were not in agreement. Mr. Westwood said that making malleable iron was simply a matter of common sense and a little chemical knowledge, but later he said that there was only one brand of iron from which he could get certain results. It was not conceivable, Mr. Field continued, that all the foundrymen in the country were using one particular brand of iron at the same time. To the minds of machinists, malleable castings were by no means uniformly reliable. He would like Mr. Hurren to tell them exactly what he meant when he said that a sample machined well. Mr. Hurren told them nothing about the thickness of his specimens, and with regard to machining may have been speaking only about the surfaces. He (the speaker) would like to know whether the samples drilled well. It appeared to him, from Mr. Hurren's figures, that some of the samples would not drill well because they contained such large amounts of combined carbon, and therefore must necessarily contain considerable amounts of free cementite. They knew that in most samples that, whilst the surface was very low in carbon, it gradually increased towards the centre; so that if the average combined carbon was 1.3 per cent., the percentage at the centre of the bar would be considerably greater, and it seemed strange to him that such bars should drill well. Professor Turner, in a series of lectures two or three years ago, emphasised the opinion that good malleable castings should contain plenty of pearlite and no free cementite, and he (Mr. Field) gathered that, if free cementite was to be avoided, the bar should not contain more than 0.9 per cent. of combined carbon even at the centre. At his foundry they always worked to very much lower percentages of carbon than those given by Mr. Hurren. With regard to the use of steel in the mixture, he asked whether Mr. Hurren recommended the mixing of steel, which meant making semi-steel castings from the cupola, for malleable-iron work. One of the causes of the formation of a skin which peeled off was high sulphur, as he almost invariably found that in this skin, when removed, there was a considerably lower sulphur than there was in the core. He had found about 0.2 per cent. in the skin and about 0.4 per cent. in the core.

MR. S. G. DOBSON referred to an experience of over twenty years ago, when he was asked by an inspector to make samples of semi-steel castings. He produced the samples, and the test-bars, which were to stand not less than 18 tons, gave a tensile strength of 30.5 tons in one case and in the other 33.2. With regard to the making of malleable castings, his own experience was that where a pure iron was the basis it always brought out the best result. With regard to heat treatment, he never allowed the castings to get cool, but had them taken straight from the mould to the oven.

The Lecturer's Reply.

MR. HURREN, in reply, said Professor Turner referred to the fact that he had stated in his paper that little attention had been paid to malleable iron. He still thought that was so. A fairly large amount of work had been published, but a great deal of it was on very academic lines, and it was very difficult to adapt it to ordinary works practice. He thought that his feelings on the matter were summed up in a very appropriate sentence by Professor Turner—namely, "that those in the trade ought to pool their experience." Mr. Reason had referred feelingly to trouble in machining. Probably Mr. Reason, as a user of malleable iron, would naturally not be in sympathy with the malleable ironfounder. Mr. Cook had remarked that fracture or structure was more important than analysis. He quite agreed with Mr. Cook as to the limitations of analysis. These examples showed that analysis alone could not be taken as a deciding factor. He would like to correct Mr. Cook with regard to the effect of raising and lowering the temperature during annealing. Far from having a detrimental effect, it improved the malleable iron considerably. Mr. Matthews had pointed out that in certain samples referred to in the paper there was a difference in the manganese percentage, and quoted a sample with 0.13 per cent. of manganese and another with 0.14 per cent. He (Mr. Hurren) scarcely thought that difference of 0.01 per cent. of manganese could have any effect. In reply to questions as to the ovens, their standard type of annealing oven was coal-fired and had two fires, one on each side of the bed, with a flue and a damper in the roof. The fire faces, as usual, stretched the whole length of the oven. They used ordinary hard coal when obtainable. With regard to the length of time in heating up, they found that, as a rule, anything from 35 to 45 hours a very reasonable time to allow for getting the oven hot until the body of the oven had a temperature of 900 deg. or 950 deg. C. He quite agreed that rushing up the temperature was injurious. Mr. Matthews also said that the temperature should not be allowed to fall below 900 deg. C. He could not agree with Mr. Matthews there; he had found no detrimental effect from lowering the temperature to 850 deg. C. or even to a few degrees lower. As to Mr. Westwood's questions about the kind of iron used, they used various brands, but it was not within his (Mr. Hurren's) province to advertise any particular brand. Such information should be given privately.

MR. WESTWOOD, interrupting, said he was not referring specially to the name of the brand, but the class of iron—whether hard-white or spotted-white or mottled pig.

MR. HURREN replied that the kind of iron they used was known as spotted-white. It was just a shade softer than the brand commonly known as hard-white. The silicon ran from 0.5 to 0.6 per cent. They also included in the mixture a grey-malleable of the nature of Low Moor iron, though it was not Low Moor iron, in which the silicon was about 1.50 per cent. When steel was introduced they used a mild steel. He did not understand the remark of Mr. Westwood that, in his experience, the more combined carbon he got in the mixture the better the result. Possibly Mr. Westwood meant carbon in the hard state, because he did not agree with Mr. Westwood that the more combined carbon there was in the annealed malleable casting the better the result. His experience had been that the more combined carbon there was in the annealed casting the harder the casting was.

MR. WESTWOOD: I meant in the hard state.

MR. HURREN went on to say that he agreed that the presence of graphitic carbon in the hard state was not a particular advantage. On the other hand it was a disadvantage because the annealing made it a weaker iron, and consequently a lower tensile test was obtained. Mr. Westwood also stated that he got a tensile strength of 22 tons per sq. in. with some irons melted in the cupola. In general practice they reckoned to get something between 22 tons and 25 tons, whilst in special irons they had got as high as 32 tons or 33 tons. But when the tensile got about 30 tons he had always found the elongation to be slightly reduced and to be somewhere in the neighbourhood of 3 per cent. As to the difference in the results of annealing when castings had been stoved in the hard state, he had not had any experience. But it was rather an interesting point. Mr. Westwood also asked whether the cupola was blown direct or had a blast belt. The cupola they used was of an ordinary type, with a wind belt and six tuyeres, three on the bottom and three on the top. As a matter of fact, the cupola was used for several years for cylinder castings before it was turned over to malleable work. As to Mr. Field's inquiry for his definition of what he meant by machining well, he explained that in their own machine shop the men who were working on malleable castings did occasionally come across some hard ones; but if he were told by a man in the machine shop that a casting machined well he took it that the casting was pretty good, while if it was pronounced a bit hard he supposed that it was not as good as it might be. As to the size of the samples and the machining they were submitted to, most of the samples for those particular tests were 4-in. diameter discs, provided with a step; they were ½ in. thick at the edge and 1¼ in. thick at the centre. Mr. Field was correct in assuming, because of the large amount of combined carbon present, some of the samples were difficult to drill. As those familiar with malleable iron knew, turning was a comparatively simple operation compared with drilling because of the thick skin, but most of the samples which he had described as machining well were drilled as well as turned. As to the combined carbon, which Mr. Field said should not be more than 0.9 per cent., he quite agreed with Mr. Field, and in the samples which he had described as particularly good the combined carbon was somewhere between 0.6 and 0.8 per cent. As to losses and failures in the course of his experiments, those he did not mention were some in which the results were negative, and therefore were not worth mentioning. As to the advisability of introducing steel, personally, he did not advocate the use of steel, particularly where the melting was to be done in the cupola, because of the liability of irregular mixing, due to charging difficulties and the large difference in the melting temperatures. At the same time, he had tried to show that steel as an addition to the mixture was in itself not detrimental, and, if anything, a slight improvement. With regard to the skin peeling off a casting, and Mr. Field's suggestion that that might be due to sulphur, the impression he gained from his own experience was that it was caused by excessive temperature or the too rapid heating-up of the annealing furnace. This also happened if the mixture of annealing ore had been exceptionally "strong," by which he meant a very high percentage of red ore being used. He was not at all sure as to the cause of the peeling of the skin of castings, but he had always associated it with too rapid malleableising.

ANNUAL DINNER OF SHEFFIELD BRANCH.

The annual dinner of the Sheffield Branch of the Institution of British Foundrymen took place on Friday night at the King's Head Hotel, Sheffield. Mr. John R. Hyde, the Branch-President, presided.

PROFESSOR C. H. DESCH, D.Sc., Ph.D., F.I.C., said the toast he had to propose was that of "The City and Commerce of Sheffield." To speak of the commerce of Sheffield at the present moment might seem to call for the exercise of a certain amount of faith, for never, he understood, had the outlook seemed so black with regard to the commerce of that town and others. But they could at least console themselves with the thought that they were not in such a bad position as many great manufacturing towns, and they could look forward to the passing away of that cloud which lay over industry at the present time. They could look forward with special confidence, as Sheffield, whenever a revival of industry took place, was so well endowed from a metallurgical point of view, and no industry could make much progress without an ample supply of metals. The great and essential feature of Sheffield industry was not the quantity or cheapness of the steel produced, but the making of good steel. As time went by, and newer countries and newer mineral resources opened up, there may be countries that might

be able to produce steel in greater quantities, and at a lower price than could be done in Sheffield, but they could not put that skill into the work which alone could produce the finest steel. Sheffield was fortunate in that respect. For centuries the reputation of Sheffield had been based upon its great skill in manufacturing. From the time when steel was made only on a small scale, and depended upon the skill of the workman, down to the present time when they had highly scientific men engaged in the industry, Sheffield had stood at the head of that industry. During the war special high-class steel had to be undertaken at short notice, and Sheffield was in a position, with its raw materials and good manufacturing facilities, together with the great skill that could be put into the work, to accomplish everything it was called upon to do. An industry such as steel-making could not grow up quickly in a new country, where the workers were new and untrained. Sheffield had behind it the tradition of many generations of skilled steel workers, supported by modern developments in the industry. As methods in manufacture changed, so the skill in production changed, but they were always dependent upon the workers, and in that respect Sheffield was fortunate, for in no other district of the world could they find in the same radius such a number of scientific metallurgists. They, in Sheffield, had one of the finest and most progressive of Universities engaged in training the men who would be required to lead those industries and assist those industries to develop. The University was there as an institution to which manufacturers could turn when they required scientific help beyond that which they already had. The University was also doing excellent work in the assistance it was giving to the lighter industries. However black the outlook might be, they could look forward with confidence, for when there was a revival in industry Sheffield would share it to a very large extent. At Sheffield they had a Civic organisation which stood high amongst the Civic organisations of the country. It contained many men who took an active part in the industrial affairs of the town. As an instance he referred to the present Lord Mayor. They knew of the excellent work that he had done in connection with the organisation of the labour connected with Sheffield's industries. Dr. Desch compared the relations between employer and employed at Sheffield with other places, and said they were particularly good, for much of which they had to thank Alderman Wardley.

THE LORD MAYOR OF SHEFFIELD (Ald. W. Wardley, J.P.), in reply, said he was proud of Sheffield at this moment, and endorsed Dr. Desch's remarks that Sheffield was in a unique position. They had more scientific metallurgists than any other town in the world. They produced the best cutlery in the world, and all they wanted was confidence. The pendulum of trade went to one extreme a while ago; the men were in the ascendant, and some of them did not use the opportunity quite as discreetly as they might have done. Now the pendulum was going the other way, and he begged of the managers not to be indiscreet to their employees. Unless employers and employed worked together in harmony other countries would overtake us in some things, but we had the elements of success amongst us if we would only learn to harmonise our efforts.

MR. J. KENT SMITH, who proposed "The Visitors," said no effort on the part of any individual, or aggregation of individuals banded together for one common purpose, could hope for complete success unless it received the practical sympathy of broad-minded, intelligent men of standing and knowledge, and that their institution had that sympathy was best instanced by simply looking round at the composition of their gathering that night.

DR. A. MCWILLIAM, C.B.E., D.Met., A.R.S.M., in responding said they had heard much about the exceedingly dark cloud that was hanging over us, and he thought the inevitable reaction that must follow after such a great war as we had had, yet certainly a large proportion of our difficulties might have been made much less, if we had all got together and tried some very clear thinking and some very straight talking. In his very humble way he had felt since he returned from India that there were a great number of "nevers" being used that were obviously wide of the mark. What had to be done at the present time was something that must come from a consideration of that which was to happen. One important steel-manufacturer said they would do well if they guessed right. It could only come by fairly and squarely facing the facts after the most careful consideration of all the elements of the problem, and without camouflage. Camouflage should be put on one side and the clear problems more studied. He asked them to look at the problem just as they would consider one in connection with the manufacture of an iron, steel, or any other type of casting for a given purpose, and solve the problem as best they could as to how they should act to-day.

MR. T. H. FIRTH proposed "Kindred Associations." He expressed regret that the President of the parent Association was not able to be with them. In Sheffield they were very proud of their kindred Associations. This particular Association was first formed as an engineering Association in 1885, and was still carrying on and doing good work.

MR. P. B. HENSHAW, in replying, referred to the difference that science, properly applied, would make. The war was won by science, commercial supremacy would be won by science, and they must look to these institutions for help in this direction.

MR. H. COLE ESTEP submitted "Institution of British Foundrymen." As a member of the American Foundrymen's Association he extended to them the heartiest wishes and best of luck, coupled with the hope that their relationships might be even closer in the future than they had been in the past, if that were possible. The foundrymen of his country had learnt a great deal by studying quality which was to be found in the workshops of Great Britain. There had been greater progress in the foundry industry in this country during the last twenty years than there was in the previous two hundred years. It was through such organisations as this. The more knowledge they had the easier it was for them to acquire knowledge, and the more they exchanged views with their fellow-men the more they had left for themselves.

THE BRANCH-PRESIDENT, in reply, referred to the value of increasing and making more widespread the knowledge they had. At their meetings they tried to get a nice homely feeling which certainly helped the discussions, and he could say with every confidence that those discussions were a true education, but education was a different thing to instruction.

Foundry Courses by Correspondence.

It has repeatedly been stated that practical applied science, such as foundry work, cannot be adequately dealt with by a correspondence course. Undoubtedly Mr. David McLain has proved the reverse. The managing director of a well-known Scotch foundry writes, in answer to inquiry for his opinion of the McLain system: "We have found the cupola instructions so satisfactory that we have now our three cupolas operating according to his instructions, obtaining better and hotter metal, with distinct savings in coke. By adopting the McLain system we have been able to undertake large and profitable business. The small outlay necessary we reckon can be saved in coke consumption within a few weeks."

Mr. David McLain, whose headquarters are at Goldsmith Building, Milwaukee, U.S.A., is offering annually a gold medal and other prizes for the greatest achievement in semi-steel, cupola melting and general foundry practice. The practical nature of the course is clearly demonstrated by the rules, one of which reads:—"Judges of the contest will be members of the McLain Alumni, and shall be three in number. This committee shall be privileged to visit any plant in which there is a contestant, if necessary, but it is obligatory that the winner give a practical demonstration."

PROTECTING WHEEL RIMS.—Many automobile wheel rims are now zinc-coated by the Sherardising process. This treatment retards rusting, which in the past impaired the life of the rims and caused occasional accidents due to fastenings giving way.

XUM

Trade Talk.

NINE vessels, of a total tonnage of 14,350, were launched during January from Clyde shipyards.

THE oil well at Hardstoft (Derbyshire) has continued to give oil by natural overflow at a uniform rate of approximately one ton per day.

THE works of Messrs. Hatley & Bassett, Limited, tin and copper smiths, in Rea Street South, Birmingham, has recently been seriously damaged by fire.

THE wages regulated by the sliding scale under the Midland Iron and Steel Wages Board were reduced 5 per cent. from last Monday until Saturday, April 2.

IT is reported that some seventy American concerns have taken steps to start branches in Canada. American industrial investments in Canada during 1920 are estimated at about $50,000,000.

MESSRS. HENRY BATH & SON have published a very useful chart showing the average monthly cash prices of copper, tin, spelter, and lead, covering a period of ten years from 1910 to 1920.

VISCOUNT FURNESS is presenting as a gift his late father's West Hartlepool residence, Tunstall Court, together with its grounds of 14 acres, to the companies forming the "Furness group," for the purpose of a convalescent home.

A SPECIAL export bureau, "Industriraadets Exportbureau," has been established at V. Boulevard 18, Copenhagen, B., by the Danish Government for the purpose of giving information concerning the productions of various firms and their capacity for export.

THE foremen and staff of Messrs. Joseph Cook, Sons & Company, Limited, Washington Ironworks, held their annual dinner at the Station Hotel, Newcastle. The directors (Messrs. Joseph Cook, J. Falshaw Cook and A. G., H. Cook) were present.

PIONEERS engaged in the production of iron and steel from the ores and sands of New Zealand have met with varying success, but up to the present there are no well-established concerns engaged in the manufacture of these most important essentials.

AT a meeting of the North-East Coast Institution of Engineers and Shipbuilders, Mr. M. E. James presented the Institution with a tablet showing the names of the winners of the Institution's gold medals in celebration of his business jubilee on the Tyneside.

THERE has recently been launched from the Jarrow Shipyard of the Palmer's Shipbuilding and Iron Company, a steel screw steamer, the "Pear Branch," which will carry a dead weight of about 7,000 tons on load draft of 23 ft. She has been built to the order of the Nautilus Steam Shipping Company.

SUBJECT to the ratification of the Anglo-Russian trade agreement, a large contract will be entered into by Messrs. Armstrong, Whitworth & Company for the repair of Russian locomotives, which will be brought by sea to the Tyne at the rate of about 20 a month. The execution of the order will occupy a few years.

THE interest which is taken by the Royal Family in any matters concerning the industrial welfare of the country is again shown by the fact that His Royal Highness the Duke of York will visit the British Industries Fair at Birmingham officially on Tuesday, March 1.

DECLARING that we were approaching probably the most serious depression shipyards had ever known, Captain Farmer, one of the directors of William Gray & Company, speaking at a gathering of the Central Marine Engine Works staff, at West Hartlepool, said drastic changes would have to take place before better times came.

AT a recent meeting of the export merchants' section of the Birmingham Chamber of Commerce, consideration was given to the difficulties of the situation created by the cancellation of orders from foreign countries, the result of the universal financial stringency which at present exists, and the fall in the foreign exchanges.

A JOINT meeting of the Society of Chemical Industry and of the Institution of Mechanical Engineers will be held at the rooms of the Institution, Storey's Gate, Westminster, on Friday, March 4, at six o'clock, when M. Paul Kestner, President of the Société de Chimie Industrielle, will read a Paper on "The De-gassing and Purification of Boiler Feed Water."

THE members of the University Board Circle of the Lyceum Club celebrated, by a dinner at the clubhouse, the admission of women to the Chemical Society. The chairman was Dr. Smedley Maclean, who expressed satisfaction over the frank acceptance of women by the Chemical Society, and alluded to the controversy in 1908 about the admission of the sex.

NOBEL INDUSTRIES, LIMITED, announce that, owing to delays due to legal formalities and printing difficulties, the definite 8 per cent. seven-year secured notes will not be ready for exchange for the allotment letters so soon as was anticipated, but a further communication will be sent in a few weeks' time requesting that the allotment letter be forwarded in order that this exchange may be effected.

As a result of a deputation from the Woolwich Employment Committee to the War Office and the Chief Superintendent of Ordnance Factories, the rule that men over 45 years shall not be engaged for temporary work in the Ordnance Factories has been suspended, and applications by men up to the age of 60, provided they are ex-employés of the Ordnance Factories and fit, will now receive favourable consideration.

THE manufacture of aluminium from ores requires a large amount of electric energy, and there is no part of the Empire where electric energy is produced more cheaply and in larger quantities than in the Province of Quebec. The aluminium manufactured in Quebec is turned out in sheets, ingots, wire, etc., and in Montreal there is large factory producing articles manufactured out of aluminium—kitchen and enamel ware.

FRANK GOUGH (41), hot stamper; Charles Gough (34), filer; and James William Pratt (26), general dealer, all of Birmingham, were charged at Smethwick with conspiring to obtain scrap iron and steel to the value of £357 2s. 6d., with intent to defraud, from William Edward Chatwin and Joseph Oliver Chatwin, of Smethwick. It was alleged that they had obtained extensive credit from a considerable number of firms without any likelihood of being able to discharge the debts incurred.

THE Council of the Sheffield Association of Metallurgists and Metallurgical Chemists has frequently during the past year considered whether any steps should be taken to amalgamate their Association with one of the several societies dealing with the economic position of engineers or applied science workers. The Council has now issued an announcement that in their view the Association should continue on its present lines, but that any member wishing to join additionally some other Association as a means of obtaining economic benefits should be perfectly at liberty to do so.

A REPORT made for the Steel and Iron Union of Germany states: "The interest in German machinery continues unabated. Orders are coming in in abundance, but we have to keep prices down owing to the competition of English and Americans. It may be that the needs of the world's markets, caused by the war, may have been exaggerated; nevertheless, they will not be satiated for a long time to come. Up to now we Germans have had the advantage of the exchange. Should the exchange improve it would be a great pity. That may sound strange, but it would render our competition with other producers far more difficult."

Personal.

THE late Mr. James Stewart Buchan, retired engineer and shipwright, Methil, left £5,249.

MR. H. BARRES has joined the firm of Furniston & Lawlor, of the Letchworth Castings Company, Letchworth.

THE late Mr. Arthur Gorell Barnes-Gorell, Glapwell Hall, Glapwell, Derbyshire, mining engineer, director of the Midland Railway Company, left £130,684.

THE late Mr. Lemuel Hill, of Wolverhampton, brass and general founder, who died on September 5, left estate of the value of £36,935, of which £24,458 is net personalty.

THE General Committee of Lloyd's Register of Shipping have elected Sir John H. Luscombe as chairman and Mr. J. Herbert Scrutton as deputy-chairman and treasurer of the Society.

SIR EDWIN F. STOCKTON, President of the Manchester Chamber of Commerce, has been elected a director of the Lancashire and Yorkshire Railway Company, in succession to the late Sir John Thursby, Bart.

THE Lords Commissioners of His Majesty's Treasury have appointed Sir Robert Robertson, K.B.E., F.R.S., D.Sc., Director of Explosives Branch, Research Department, Woolwich, to be Government Chemist in succession to Sir J. J. Dobbie, who has retired.

THE late Earl of Bessborough, K.P., chairman of the London, Brighton and South Coast Railway Company, of Guest, Keen & Nettlefolds, Limited, etc., who died at Birmingham on December 1, aged 69, left unsettled property of the gross value of £272,890, with net personalty £271,739.

AT a general meeting of the South Wales Institute of Engineers, Mr. Westgarth Forster Brown, M.Inst.C.E., chief mineral adviser to H.M.'s Office of Woods and Forests, Deputy-Gaveller of the Forest of Dean, and Chief Mineral Surveyor to the Duchy of Cornwall, entered upon the duties of president of the Institute, of which his father, the late Mr. T. Forster Brown, was president over 25 years ago.

IRON AND STEEL MARKETS.

Pig-Iron.

The month just closed has been by universal consent one of the most trying periods experienced in the pig-iron trade for many years, with demand almost completely inactive, and production reduced to much below the normal level. Home consumption has decreased to a substantial extent, the closing down of manufacturing works having diminished demand in this direction, while the pig-iron export returns for January from the Tees were reduced to the insignificant total of 6,178 tons shipped to destinations overseas, with only 5,610 tons going coastwise. In explanation of this it should be stated that the diversion of traffic to other ports owing to the tugboatmen's strike, the severity of competition abroad, and the high prices for British pig-iron enhanced by the state of the foreign exchanges, have all tended to almost completely hold up our foreign trade. Before the war the Tees pig-iron exports averaged 100,000 tons a month. Now they have fallen to a little more than a tenth of that total, and of the quantity shipped in January nearly half went to coastwise ports. The serious conditions thus disclosed in the Tees-side pig-iron trade have influenced the local ironmasters to make still further reductions in prices, and last week another cut of 20s. was made in Cleveland quotations, which, it is stated, has brought values below the cost of production, yet whilst this may be so, Cleveland prices exceed by 30s. to 50s. per ton the c.i.f. cost of Belgian pig-iron. This latter is now being freely offered on British markets at prices ranging from 165s. to 145s. per ton, and with such quotations it is impossible for local manufacturers to compete. The result of this competition has not as yet been fully appreciated, but already some blast-furnaces in this district have been damped down, and others are expected speedily to follow, until output more nearly corresponds to the demand. In these days of high prices makers simply cannot afford to manufacture for stock, and unless the demand improves they will have no alternative but to lay the furnaces, and incidentally the workmen, idle. The new range of quotations is as follows :—No. 1 Cleveland, 205s. home, 210s. export; silicious iron, 205s. home, 210s. export; No. 3 Cleveland G.M.B., 195s. home, 200s. export; No. 4 foundry, 194s. home, 199s. export; No. 4 forge, 192s. 6d. home, 197s. 6d. export; mottled, 192s. 6d. home, 197s. 6d. export; white, 190s. home, 195s. export. The downward move in quotations has been considerably facilitated by the further drop of 5s. per ton in Durham coke prices, which has brought the figure to 54s. 6d. per ton at the ovens for ordinary blast-furnace qualities, and 57s. for qualities low in phosphorus. In South Staffordshire hopes are also entertained that the coming de-control of fuel, the high cost of which has been an obstacle in the way of reducing selling prices, may yield some advantage to smelters. The recent reduction in coke did nothing to stimulate the pig-iron market, furnace owners preferring to put furnaces out of blast to producing for stock under present conditions. Staffordshire forge iron is 5s. cheaper at £11 15s., and foundry 10s. down at £12 5s., but Staffordshire brands were relatively higher than those of other districts, and are now brought into closer relationship. The continued weakness prevailing in the Scottish pig-iron markets has had the effect anticipated in reducing prices, No. 3 foundry now being quoted at £11 10s. on trucks, with No. 1 at £11 15s. The depression is becoming accentuated, and further price movements would not be surprising with a view to stimulating demand. In the Lancashire area business in pig-iron is now only possible on a limited scale, consumers on the whole inclining to the opinion that still more drastic cuts in prices must be effected by makers before any general revival of trade can be expected. As expected in an unsettled market, buyers are exercising extreme caution in dealings, with the result that small lots only are changing hands to meet immediate needs.

Hematite.

Business in the East Coast hematite continues practically lifeless, but the inquiry from abroad has shown a little more activity, and if makers could be induced to further price concessions, it is thought that an expansion in this branch of the trade is not improbable. But all round confidence is shaken, and until that is restored business must be on a limited scale. Current home prices :—East Coast mixed numbers, 220s., No. 1, 222s. 6d. A Barrow report states :—The general position of the hematite trade of North Lancashire and South Cumberland has undergone a further change since last week, prices having been reduced to £11 for mixed numbers. There is very little iron being produced, with only one furnace working at Ulverston and one at Carnforth. Barrow and Millom are quite idle, and Askam has not done a turn for months past. In one or two cases buyers are wanting delivery of iron, and it is likely that some of the furnaces that were damped down will be put into operation for a short time to make the necessary iron. Business is idle, and the disposition of buyers is to hold out for a further reduction in values. Makers are quoting £11 per ton net f.o.t. for mixed numbers of Bessemer iron, with £12 10s. per ton for special brands. There have been negotiations going on with a view to getting a removal of payment for special labour conditions which have ceased to prevail. As yet a settlement has not been arrived at.

Ore.

With many furnaces partly or quite idle, business in the foreign ore market has naturally relapsed into a similar condition, and in the Tees-side district especially business is practically at a standstill. Imports, too, are on a rather heavy scale, and with freights coming down almost day by day prices of rubio show a corresponding declining tendency, latest quotations ruling round 40s. per ton c.i.f. Tees for best quality. At Tyne Dock, last week, the "Rolf," from Bilbao, entered with 1,800 tons; the "Kostrena," from Port Briera, 4,050 tons; the "Achuri," from Algiers, 3,700 tons for the Consett Iron Company, Limited; the "Belgot," from Bilbao, 3,036 tons; the "Levenpool," from Algiers, 8,050 tons; and the "Capac," from Port Briera, 4,100 tons for Palmers Shipbuilding and Iron Company, Limited. At Tyne Main the "Erika," from Huelva, has unshipped 3,650 tons of copper ore for Messrs. Scott Bros., Limited. At Barrow, following the cut in ore prices, Spanish sorts have been reduced several shillings per ton, and are now quoted at 41s. per ton delivered. This compares with 55s. to 70s. per ton net for native sorts. East Coast coke, which is almost wholly used in the Furness district, has been further reduced 5s. to 70s. per ton delivered. In West Cumberland, Hodbarrow iron ore mines, Millom, the largest in the world, closed down for an indefinite period last week. Some 2,000 hands are affected. The Millom ironworks were damped down recently, and this means that nearly the entire working population of the town and district is now workless. The position is worse than at any time during the last half-century.

Scrap.

The inactivity generally prevailing in all branches of the manufacturing departments of the iron and steel trades has naturally extended to the markets for scrap material, in which business continues completely stagnant, most works having sufficient stocks in hand for all immediate requirements. Appended are the current quotations ruling in the various districts :—Scotland : Heavy steel, £6; heavy basic, £5; faggoted basic, £4 5s.; steel turnings, £5 10s.; steel borings, £5; heavy piling, malleable, £6 10s. to £7 10s.; best machinery, £10 10s.; heavy cast (ordinary), £9 10s. North of England : Heavy steel, £5 10s.; steel turnings, £4 12s. 6d.; steel borings, £4 7s. 6d.; heavy wrought-iron piling £8; bushelling scrap, £7 10s.; cast-iron scrap, £9 15s. Lancashire : Cast-iron scrap, £10; heavy wrought iron, £6; steel turnings, £3 15s. South Wales : Heavy steel, £5; bundled steel and shearings, £4 10s.; mixed I. and S., £2 to £5; heavy cast iron, £6; good machinery for foundries, £9 10s.

Steel.

Conditions in the Sheffield steel trade, although depressed in certain branches, do not by any means altogether justify the pessimistic views expressed in some quarters, inquiries of late having been much more satisfactory in volume, and with prices generally undergoing the process of deflation, there should be no tangible reason why revived activity may not be anticipated. Even granting that reduced values, so far, only apply in the case of the lower grades of steel—hoops, strips, and wire-rods, for example, which can be made from cheaper qualities of imported material, and are now on offer at prices with which English makers cannot compete—the downward tendency in values may probably in due course extend to the more expensive qualities. So far, at all events, acid varieties have been immune from foreign competition, while high-speed and special steels have maintained prices, for the very good and sufficient reason that there is little prospect at present of any reduction in the cost of production which would justify a movement in that direction. The last-mentioned qualities are, however, only in poor demand. Among the sections of Sheffield

trade still fairly well employed are included makers of mechanics' tools, while farm and garden tools and appliances are in seasonal demand, as far as home markets are concerned, but export orders are scarce. Inquiries for agricultural implements are below expectations, and only a moderate demand is experienced for motor constructional material in the form of axles, tyres, springs, and other parts, usually an important branch of Sheffield manufacturing trades. With reference to export trade in steel material, it would appear that Germany is making serious encroachments on our Colonial markets, Australia alone among the Dominions overseas having banned the entrance of our late enemy's products to their ports. South Africa, on the other hand, has accepted some very substantial and lucrative contracts from German manufacturers for railway material, while Egyptian authorities have placed orders for large quantities of railway axles and wheels, and one hundred locomotives for Spain.

In the South Wales area, though for the time being there is acute depression, there are expectations of an early revival of trade as conditions become more stabilised. Inquiries from foreign markets show an improvement, and a limited amount of business has been reported. The steel sheet trade, which has hung quiet for some time, is slowly brightening. It is announced that Messrs. Gilbertson's Steel Mills, Pontardawe, are restarting, and also that eight mills of the South Wales Steel Works, Llanelly, are resuming work, thus giving work to 1,600 men altogether. Home steel bars are now being quoted at £13 10s., but Belgian and German bars are freely on offer at £11 10s. In the West of Scotland, semi-finished materials, such as sheet bars and billets, are being brought into this district in fairly large quantities, and re-rollers are thus obtaining some advantage over the home producer, and hitting the maker of semi-finished material at the same time. Makers of steel are booking little new business, as consumers are looking for still lower prices, and most of the works are on short time. In the black sheet trade makers are experiencing great difficulty in keeping their mills employed, notwithstanding the substantial fall in their prices, and the galvanised article is in poor demand also. The steel trade is idle at Barrow so far as production is concerned, and there is nothing doing in the mills with the exception of the hoop works owned by the Barrow Steel Company, which are separate from the general works. A good output is being maintained of hoops, etc., and supplies of raw material are adequate. Last week a cargo of steel rail crop ends arrived at Barrow from Antwerp. Steel prices are unchanged, but are, to a great extent, nominal. Business is at a standstill.

Finished Iron.

Conditions in this branch of the iron and steel trade remain practically stationary, makers having still uncompleted orders on hand continuing work on a limited scale, but little fresh business is coming forward, nor does an improvement appear probable until prices can be lowered to something nearer the parity of those of Continental makers. Perhaps the most hopeful sign of an approach to that position are the recently issued ascertainments of wages as regulated by the sliding scale, that of the Midland Iron and Steel Wages Board showing the first reduction since the outbreak of war in 1914. At that date the puddling rate was 9s. 6d. a ton, at the end of last year it was 49s. 3d. The figures of the Board are not available for publication, but it is understood the average net selling price of the seventeen firms upon whose experience the sliding scale is based shows a reduction of about 8s. 10d. a ton, compared with the returns for October and November, while output fell off by well over 2,000 tons. South Staffordshire makers of common bars find demand small and irregular, and the mills are getting short of orders. Belgian bars, such as are used in the nut and bolt industry, have appreciated from £14 to about £16, by reason of the altered exchanges, but while South Staffordshire bars remain at £26 10s., business is not likely to be diverted from abroad. Users have considerable stocks of Belgian material, and require but little of the home product. A fall in gas strip from £33 to £29 10s. was in accordance with anticipation, as this material usually follows bars. It is not easy to get reliable quotations for puddled bars, so many of the furnaces being idle, but probably £20 would be an outside price. In the Scottish market, for fine material the price for crown quality bars is now £25 per ton for Glasgow delivery, but it is probable that further reductions will be necessary before much fresh business materialises. Export trade generally is of very meagre proportions, and buyers abroad as well as at home are apparently quite content to hold back meantime. The imports of iron, steel, etc., at Hull from abroad in the past week were :—Iron : Pig, 599 tons (Bleasdale & Company), 32 tons (Wilsons and N.E.R. Company); bar, 10 tons (Hull and Netherlands S.S. Company), 212 tons (Bleasdale & Company), 163 tons (Wilsons and N.E.R. Company); plates, 30 tons (Charles Graham & Company), 282 tons (Furley & Company), 602 tons (Wilsons and N.E.R. Company), 58 tons (Bleasdale & Company). Goole :—Iron : 2,090 plates, 5,081 bars, 913 bundles ditto, 353 castings, 107 joists, 832 plates. Steel : 4,560 billets, 61 bundles bars. Zinc : 3,283 plates (order). Grimsby :—Iron : 391 billets, 147 bars, 498 bundles ditto, 48 plates, 2,339 castings. Steel : 391 billets, 184 sheets. Staffs. marked bars are down to £29 10s.

Refractories.

The general position of the refractories market to-day is practically the same as last week, and the demand for crucible ganister and crucible making clays for the Sheffield crucible steel works is still maintained.

Orders for steel foundry sand and steel moulders' composition are not so plentiful, as many of the largest foundries are still working from accumulated stocks. For iron foundry sand the demand is constant. The market for silica bricks, and firebricks is still good, and the demand for magnesite bricks is very large.

Owing to the unchanged position of the wages, manufacturers have not been able to reduce prices except in the cases of firms who have placed contracts for definite quantities of materials, when manufacturers are inclined to quote slightly easier terms. The current prices therefore are similar to the list quoted in our last issue.

Tinplates.

Markets in this department of the metal trades remain in a lifeless condition, and apart from a few inqpiries from Italy and Scandinavia there were no signs of any revival of activity. It is generally agreed that very little fresh business is coming along. Quotations rule as follows : Cokes, 20 by 14, 33s. 6d. to 36s. 6d.; do. quarters, 36s. to 38s.; cokes, 20 by 10, 50s. to 52s.; do., 28 by 20, 67s. to 73s.; ternes, 28 by 20, 73s. to 75s. It is reported that America has been offering 28 by 20 plates at an equivalent of 32s. 6d. basis c.i.f.

Metals.

Copper.—Closing on Friday with a firmer tendency, due doubtless to the announcement of the withdrawal of the E.P.D. and encouraging cable advices from America business in Monday's opening market was distinctly more active, while the improvement noted at the week-end was well maintained. Demand for forward copper on consumer's account developed further strength, three months realising up to £72 10s., with March and April 5s. below that figure. Refined descriptions were also firmer, both electrolytic and wire bars showing an improvement in values on the day's transactions. Closing prices :—Cash : Wednesday, £69 5s.; Thursday, £68 5s.; Friday, £69 15s.; Monday, £72; Tuesday, £72. Three Months : Wednesday, £69 5s.; Thursday, £68 5s.; Friday, £70 5s.; Monday, £68 5s.; Tuesday, £72 10s.

Tin.—The week's market for tin opened with a fairly strong demand for prompt metal, and in the absence of Eastern cables the tone was firm at the commencement, but temporarily reacted on freer offerings from sellers. An outstanding feature of market movements was a sustained inquiry for near dates, quite a large volume of business operating for February deliveries. A good turnover of metal sold was recorded, and markets closed strong with an all-round improvement in values for both positions. Closing prices :—Cash : Wednesday, £162 10s.; Thursday, £155 10s.; Friday, £164; Monday, £166 10s.; Tuesday, £164. Three Months : Wednesday, £168 15s.; Thursday, £161 10s.; Friday, £169 5s.; Monday, £174 10s.; Tuesday, £169.

Spelter.—In the market for spelter inquiries were in fairly good volume, and with fewer sellers offering buying on home consumer's account was active for both near and forward positions, closing firm with March deliveries quoted £25, April £25 5s., and May £25 10s.

Lead.—Sellers offering more liberally some weakening of values followed, both near and forward soft pig showing a loss on balance of 2s. 6d. Transactions comprised February at £22 12s. to £22 10s.; April, at £23; and May at £22 5s. to £23. English remained steady and unchanged at £24 10s. Settlement price, £22 12s. 6d.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

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December 31st, 1920

Authorised Capital	*£45,200,000*
Subscribed Capital	*38,116,050*

LIABILITIES:	£
Paid-up Capital	10,859,800
Reserve Fund	10,859,800
Current, Deposit and other Accounts	371,841,968
Acceptances and Engagements	27,849,904

ASSETS:	
Coin, Notes and Balances with Bank of England	62,493,818
Cheques in course of Collection	7,702,350
Money at Call and Short Notice	18,492,013
Investments	51,766,315
Bills Discounted	57,671,879
Advances	189,719,805
Liabilities of Customers for Acceptances and Engagements	27,849,904
Bank Premises	3,883,759
Shares of Belfast Banking Company and The Clydesdale Bank	3,257,415

Copies of the Balance Sheet, audited by Messrs. Whinney, Smith & Whinney, Chartered Accountants, may be obtained at any Branch of the Bank

HEAD OFFICE: 5, THREADNEEDLE STREET, LONDON, E.C.2

OVER 1,500 OFFICES IN ENGLAND AND WALES

OVERSEAS BRANCH: 65 & 66, OLD BROAD STREET, LONDON, E.C.2

AFFILIATED BANKS:

BELFAST BANKING COMPANY LIMITED

OVER 110 OFFICES IN IRELAND

THE CLYDESDALE BANK LIMITED

OVER 160 OFFICES IN SCOTLAND

Company News.

Greenwood & Batley, Limited.—Interim dividend of 2½ per cent. on ordinary.

Birmingham Railway Carriage & Wagon Company, —Dividend of 10 per cent.

Dalmellington Iron, Limited.—Interim dividend of 9d. per share, free of tax (being at rate of 7½ per cent. per annum), on ordinary.

R. W. Crabtree & Sons Limited.—Payment of the past half-year's dividend on the 8 per cent. cumulative participating preference shares will be postponed.

Briton Ferry Canister Company, Limited. — Capital £50,000 in £1 shares. To carry on the business of steel, tin, terne and black plate manufacturers, and merchants, etc.

W. C. Willis & Company, Limited.—Capital £10,000 in shares £1 shares, to acquire the business of W. C. Willis & Company, 90, Mitchell Street, Glasgow, iron, steel, and metal merchants, and agents.

J. Hay & Sons, Limited.—Capital £250,000 (£1). To carry on the business of shipowners, shipbrokers, shipbuilders, engineers, etc. First directors: W. Hay, J. Hay, and J. Hunter, all of Glasgow.

Refractory Products, Limited.—Capital £1,200 in £1 shares, to carry on the business of furnishers and suppliers of certain requirements in connection with the business of iron and steel founders, engineers, etc.

Scottish Iron and Steel Company, Limited. — The directors recommend that powers be given them, by alteration in the articles of association, to use the reserve fund for the purpose of the business of the company.

Walter Scott, Limited.—The directors have decided to pay a dividend at the rate of 6 per cent. per annum upon the preference shares and an interim dividend of 6d. per share upon the ordinary shares for the half-year ending December 31, 1920.

Bristol & South Wales Railway Wagon Company, Limited.—Including £2,249 brought forward, net profit for 1920 is £16,407. Further dividend at rate of 10 per cent. per annum, making 10 per cent. for year, less tax, and carried forward £1,407.

Mead Engineering Works, Limited.—Capital £5,000 in £1 shares, to carry on the business of mechanical, electrical, and general engineers, oxy-acetylene, electrical, and other welders, marine engineers, etc. The permanent directors are:—G. E. Mead, F. Griffiths, and A. E. Mead. Registered offices: Hurman Street, Bute Docks, Cardiff.

Graham & Sons, Limited.—Capital £5,000 in £1 shares. To carry on the business of electrical engineers, manufacturers of electrical machinery, internal combustion and general engineers, etc. The first directors are: J. P. Graham (permanent), C. P. Graham, and S. E. Graham. Secretary: Jessie Bryce. Registered office: Sun Insurance Buildings, Collingwood Street, Newcastle.

Yorkshire Railway Wagon Company, Limited.—The gross profits for the past year amounted to £50,824. Directors recommend a further dividend of 2s. per share on the £2 shares and 1s. per share on the £1 shares, making 4s. and 2s. per share respectively for the year. £159 has been set aside to reduce the cost of freehold properties, £6,000 added to the reserve, increasing that fund to £123,500, and £2,913 carried forward.

Associated Lead Manufacturers, Limited, was incorporated as long ago as July, 1919, with a nominal capital of £1,500,000, in 1,000,000 7½ per cent. cumulative preference and 500,000 ordinary shares, all of £1 each. A document on the Somerset House file now shows that a purchase consideration of £757,513 is payable in cash to the promoters, H. J. Enthoven & Sons, Limited, for 18,753 ordinary shares of £10 each in Locke Lancaster and W. W. and R. Johnson & Sons, Limited, and 186,688 ordinary shares of £1 each in Walkers, Parker & Company. In addition to this, £5,329 is payable in cash to Mr. Hy. J. Enthoven and £24,960 to Mr. R. Tilden Smith. The directors are: Colonel J. Foster, F. C. Hill, H. J. Enthoven, E. M. Johnson, C. Enthoven, R. Foster, C. A. Rowe, and H. C. Rowe. The registered office is at 70, Lombard Street, E.C.

A PETITION was presented January 25 by Messrs. C. H. Joyce, Limited, 134, Southwark Street, S.E., for the winding up of St. Anthony's Foundry, Limited. Hearing, Town Hall, Eastbourne, February 22. Messrs. Harris, Chetham & Cohen, 25, Finsbury Square, E.C., solicitors.

LONDON BRONZE AND METAL FOUNDRY, LIMITED. By resolution of the shareholders, it was resolved December 29, and confirmed January 14:—That the company be wound up voluntarily. Mr. F. A. Bell, Billiter House, Billiter Street, E.C., chartered accountant was appointed liquidator. Claims to liquidator by March 22.

Gazette.

RESOLVED January 18:—That Steel (Sheffield), Limited, be wound up. Mr. C. Turner, 155, Norfolk Street, Sheffield, chartered accountant, liquidator. Claims to liquidator by March 11.

IN pursuance of Section 188 of the Companies (Consolidation) Act, 1908, a meeting of creditors of the Croydon Art Metal Company, Limited, will be held at 17, Sidney Road, Stockwell, on February 10, at 1.

IGNORE THE REST, 1
USE THE BEST:—
"LINICORE"
Write for Sample and Money-saving quotation to
BARTOLINE (HULL) LTD.,
OIL REFINERS, HULL.

DO YOU REQUIRE CASTINGS From 1 cwt. to 2 tons each?
The NORTHGATE IRONWORKS Co.
(Proprietors, R. Boby, Ltd., Associated with Vickers, Ltd.),
RAIL SIDING, BURY ST. EDMUNDS, SUFFOLK.
Finest Modern Foundry in the Eastern Counties.
Speciality: MACHINE MOULDING.
PROMPT DELIVERIES.
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TINPLATES,
BLACKPLATES,
TERNEPLATES.

For Prices apply with Specification to:
OSCAR MOENICH & Co. Ltd.,
Billiter House, Billiter Street, London, E.C.

TENDERS.

GREAT WESTERN RAILWAY.—The Directors of this Company are prepared to receive tenders for the supply of the undermentioned Iron and Steel Goods from the 1st of March, 1921, to the 30th of June, 1921.

1.—Laminated Springs
2.—Helical and Volute Springs.
3.—Steel Tyres.
4.—Steel Axles and Forgings.
5.—Iron Plates and Bars.
6.—Steel Plates and Sheets.
7.—Steel Bars and Blooms.
8.—Steel Castings (Wheel Centres and Bosses).
9.— Do. (Miscellaneous).
11.—Chain and Special Iron for Chain Manufacture.
12.—Tubes and Fittings.
13.—Solid Drawn Steel Tubes.
14.—Cast Iron Socket Pipes, Lamp Posts, Frames and Covers, &c.
15.—Galvanized Sheets.
16.—Tool Steel.

Specifications and forms of tender (upon which alone tenders will be received), may be obtained on application to the Stores Superintendent at Swindon.

Tenders addressed to the undersigned, and marked outside "Tender for Iron and Steel," will be received not later than 10 a.m. on Wednesday, the 23rd instant.

The Directors do not bind themselves to accept the lowest or any tender.

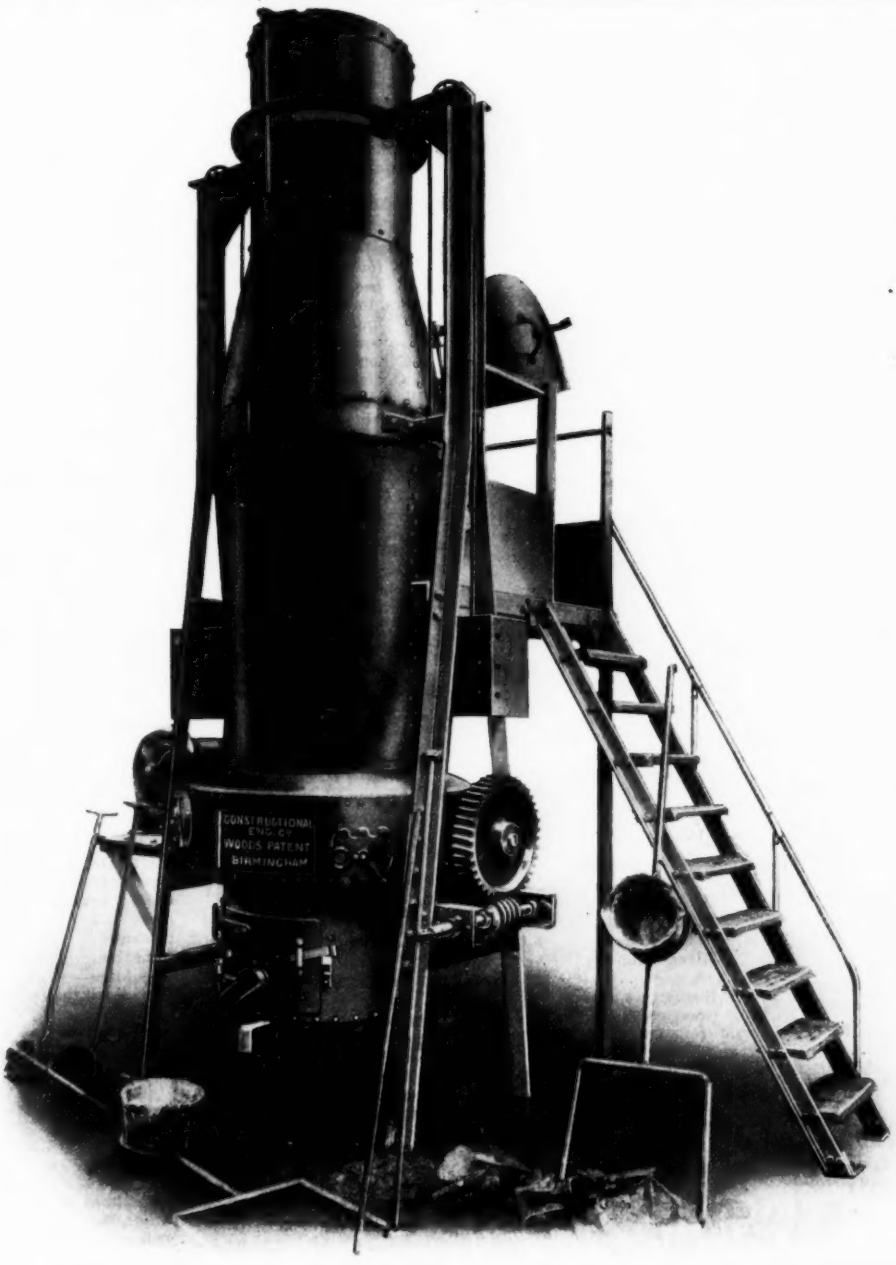
A. E. BOLTER, SECY.

Paddington Station, London, 9th February, 1921.

Air Receivers,
Cupolas,
Cupolettes.
Core Stoves,
Foundry Ladles,
,, Requisites,
Hoists.

Makers of
EFFICIENT FOUNDRY PLANT.

Moulding Machines,
and Boxes,
Runways,
Sand Mills,
Shaking Barrels,
Sand Conveyors.



The Illustration is of WOOD'S Patent Cupolette complete with Stage and direct-coupled Fan and Motor. Melting Capacity 30 cwt. per hour. Worm Gearing fitted for tilting Cupolette for relining.

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CONSTRUCTIONAL ENGINEERING CO., LTD.,
TITAN WORKS, Charles Henry Street, BIRMINGHAM.

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Invite you to visit
STAND 424
at
British Industries Fair, BIRMINGHAM
Feby. 21st to March 4th.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	72	0	0
Three months.. ..	72	10	0
Electrolytic	77	0	0
Tough	74	0	0
Best selected	75	0	0
Sheets	124	0	0
India	124	0	0
Wire bars	78	5	0
Do. Feb.	78	5	0
Do. Mar.	78	5	0
Ingot bars	77	0	0
H.C. wire rods.. ..	85	0	0
Off. aver. cash, Jan.	71	1	4⅜
Do. 3 mths., Jan..	71	9	4⅝
Do. Settlement Jan.	71	0	2⅝
Do. Electro, Jan...	80	3	1⅛
Do. B.S., Jan. ..	77	13	9
Aver. spot, copper.. Jan.	70	19	9¼
Do. Electro, Jan...	81	3	8¾
Solid drawn tubes ..			17d.
Brazed tubes			17d.
Wire			14½d.
Yellow metal rods..			9½d.
Do. 4x4 Squares ..			12d.
Do. 4x3 Sheets ..			12d.

BRASS.

Solid drawn tubes..	14⅜d.
Brazed tubes	17⅜d
Rods	13⅜d.
Sheets to 10 w.g. ..	13d.
Wire	12⅞d.
Rolled metal ..	12½d.

TIN.

	£	s.	d.
Standard cash ..	164	0	0
3 Months..	169	0	0
English	161	0	0
Bars	163	0	0
Chinese	159	10	0
Straits	187	10	0
Australian	177	10	0
Eastern	236	0	0
Banca	191	0	0
Off. aver., cash, Jan.	190	13	11½
Do. 3 mths., Jan...	195	18	11⅞
Do. Sttlment., Jan.	190	10	0
Aver. spot, Jan. ..	190	9	6¼

SPELTER.

	£	s.	d.
Ordinary	25	7	6
Remelted	18	15	0
Hard	17	10	0
Electro 99.9	35	0	0
English	27	0	0
India	21	10	0
Prime Western ..	26	0	0
Zinc dust	60	0	0
Zinc ashes	6	5	0
Off. aver., Jan. ..	25	15	7½
Aver., spot, Jan. ..	25	5	5¾

LEAD.

	£	s.	d.
Soft foreign ppt ..	22	10	0
English	24	10	0
Off. average, Jan...	23	12	6½
Average spot, Jan.	23	7	8¼

ZINC SHEETS.

Zinc sheets, spot ..	39	0	0
Do. V.M. ex. whf.	40	0	0
Do. ppt., f.o.b., N.Y.			—
Dutch	39	0	0
Boiler plates	36	0	0
Battery plates ..	36	0	0

ANTIMONY.

English regulus ..	37	5	0
Special brands ..	42	0	0
Chinese	24	0	0
Crude	21	0	0

QUICKSILVER.

Quicksilver.	12	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	19 0 0
75%	29 0 0
Ferro-vanadium—	
35/40% ..	30/- lb. va.
Ferro-molybdenum—	
70/80% ..	7/9 lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/6 lb.
Ferro-phosphorus, 20/23%,	£49
Ferro-tungsten—	
80/85%, carbon low	2/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
4/6% car.	£37 10
6/8% car.	£37
8/10% car. ..	£36 10
Ferro-chrome—	
Max. 2% car. ..	£87
Max. 1% car. ..	£104
Max. 0.75% car. ..	£123
65/75%, carbonless	3/- lb.
Nickel—99·8%, cubes or pellets ..	£210
Cobalt metal—97%..	20/- lb.
Aluminium—98/99%	£165
Metallic Chromium—	
98/99%	7/6 lb.
Ferro-manganese—	
76/80%, loose ..	£28
76/80%, packed ..	£28
76/80%, export ..	£29
Metallic manganese—	
98/99%, carbonless	3/6 lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 3 2
Finished bars, 18% tungsten	4 0
Scrap pieces	5d.
Turnings and swarf..	3d.

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..4s. cwt
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 5d.
Turnings and swarf .. 3d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy Steel	5	0	0			
Bundled steel & shearings			4	10	0	
Mixed iron & steel ..	2	0	0	5	0	0
Heavy cast iron ..			6	0	0	
Good machinery for foundries ..			9	10	0	
Cleveland—						
Heavy steel ..			5	10	0	
Steel turnings ..			4	12	6	
Steel borings ..			4	7	6	
Heavy wrought iron piling			8	0	0	
Bundling scrap ..			7	10	0	
Cast-iron scrap ..			9	15	0	
Lancashire—						
Cast iron scrap ..			10	0	0	
Heavy wrought ..			6	0	0	
Steel turnings ..			3	15	0	
London—						
Copper (clean) ..			54	0	0	
Brass (clean) ..			34	0	0	
Lead (less usual draft)			18	0	0	
Tea lead			16	0	0	
Zinc			11	10	0	
New aluminium cuttings ..			90	0	0	
Braziery copper ..			44	0	0	
Gun metal ..			48	0	0	
Hollow pewter ..			120	0	0	
Shaped black pewter			80	0	0	

PIG-IRON.

N.-E. Coast—	
Foundry No. 1 ..	205/-
Foundry No. 3 ..	195/-
Forge No. 4	194/-
Mottled	192/6
Hematite No. 1 ..	222/6
Hematite M/Nos. ..	220/-
Midlands—	
Staffs. common ..	195/-
,, part-mine forge	235/-
,, ,, foundry	245/-
,, Cold blast ..	360/-
,, basic	195/-
Northants forge ..	217/6
,, foundry No. 3	230/-
,, basic.. ..	205/-
Derbyshire forge ..	225/-
,, foundry No. 3	235/-
,, basic ..	230/-
Scotland—	
Foundry No. 1 ..	235/-
,, No. 3 ..	230/-
Hematite M/Nos. ..	230/-
Sheffield (d/d district)—	
Derby forge	—
,, foundry No. 3	—
,, basic	—
Lincs. forge	215/-
,, foundry No. 3	220/-
,, basic	190/-
E.C. hematite ..	233/-
W.C. hematite ..	240/-
All d/d in the district.	
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, foundry No. 3	—
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry..	—
Glengarnock foundry	—
Gartsherrie foundry	—
Monkland foundry ..	—

FINISHED IRON & STEEL.

Iron—	£	s.	£	s.	d.
Bars (cro'n)	24	0	26	10	0
Angles ..	24	10	27	0	0
Tees to 3 united ins. ..	25	0	27	10	0
Nut and bolt ..			26	10	0
Hoops			26	5	0
Marked bars (Staffs.) ..			29	10	0
Gas strip ..			29	10	0
Bolts and nuts, ½ in. × 4 in.			51	0	0
Steel—					
Ship plates ..			22	10	0
Boiler plates ..			29	0	0
Checquer plates			25	10	0
Angles			21	0	0
Tees			22	0	0
Channels ..			21	10	0
Joists			21	0	0
Rounds, ½ in.–3-in.			22	0	0
Rounds, 3 in.–5½ in.			21	0	0
Flats, 5 in.–8 in.			21	10	0
Flats over 8 in.			21	0	0
Rails, heavy ..			21	0	0
Fishplates ..			27	0	0
Hoops			23	0	0
Black sheets, 24 g.			24	10	0
Galv. cor. sheets, 24 g.			26	0	0
Galv. fencing wire, 8 g. plain ..			31	10	0
Rivets, ½ in. dia			36	0	0
Billets, soft ..			13	10	0
Billets, hard ..			14	10	0
Sheet and tin bars			13	10	0

PHOSPHOR BRONZE.

ROLLED.	Per lb. s. d.
⅛ in. to 1 in. wide ..	2 0½
1 in. to 1½ in. wide ..	1 11½
1½ in. to 2 in. wide ..	1 10½

STRIPS.	s. d.
2 in. to 6 in. to 26 S.W.G.	1 9¾
6 in. to 12 in. to 26 S.W.G.	1 9¾

SHEETS.	s. d.
12 in. to 18 in. to 24 S.W.G.	1 10
18 in. to 24 in. to 24 S.W.G.	1 10¾
24 in. to 30 in. to 20 S.W.G.	1 11¾
30 in. to 36 in. to 16 S.W.G.	2 0¼
36 in. to 42 in. to 16 S.W.G.	2 1¼

EXTRAS.

FOR GAUGE: Any width up to 36 in. wide, ½d. per lb. per thinner gauge.

DRAWN RODS.	s. d.
⅛ in. to ½ in. dia. in random lengths / 5/16 in. to 1½ in. dia. in random lengths	1 10½
Over 1½ in. to 1¾ in. ..	1 10½
Tubes—basis price ..	2 0½

Delivery 2 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/3 to 1/9
Rolled—	
To 9 in. wide	1/10½ to 2/4½
To 12 in. wide	1/11 to 2/5
To 15 in. wide	2/- to 2/6
To 18 in. wide	2/1 to 2/7
To 21 in. wide	2/2 to 2/8
To 24 in. wide	2/3 to 2/9
Ingots for spoons and forks ..	1/3 to 1/9
Ingots rolled to spoon size ..	1/6 to 2/-
Wire round—	
3/0 to 10. G. ..	2/1 to 2/8

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	33.25
No. 2 foundry Valley..	30.00
No. 2 foundry, Birm. ..	27.50
Basic	30.96
Bessemer	33.96
Malleable	33.96
Grey forge	33.96
Ferro-manganese, Atl. port	100.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	43.50
O.-h. billets	43.50
O.-h. sheet bars ..	47.00
Wire rods	57.00
	Cents.
Iron bars	2.70
Steel bars	2.35
Tank plates	2.65
Beams, etc.	2.45
Skelp, grooved steel ..	2.45
Skelp, sheared steel ..	2.65
Steel hoops	3.05
Sheets, black, No. 28 ..	4.35
Sheets, galv., No. 28 ..	5.70
Sheets, blue an'l'd, 9&10	3.55
Wire nails	3.25
Plain wire	3.25
Barbed wire, galv. ..	4.10
Tinplate, 100-lb. box ..	$7.00

COKE.

Welsh foundry	72/6
,, furnace	57/6
Durham & North foundry	70/-
,, furnace	54/6
Other Districts, foundry	77/9
,, furnace	55/-

SWEDISH IRON.

	£ s. d.
Bars, hammered basis sizes ..	Basis price.
Rolled Ordinary— Assortment ..	Basis price.
Nail Rods— Square, round and flats ..	31 0 0 to 38 0 0
Keg Steel } about Faggot Steel } £50	Prices nominal.

Blooms—
Single welded .. £20 to £25

Billets—
Single and double welded .. £22 to £27

Pig-Iron—
Grey, white or mottled .. £15 to £20

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 2 in.	Over 2 in.
Gas ..	net	−5%
Water ..	+10 %	+ 3¼%
Steam ..	+21¼%	+13¼%

REFRACTORIES.

	£ s. d.
Magnesite bricks, 2½ in., d/d	137 10 0
Do. 3 in., d/d	165 0 0
Common firebricks, 2½ in., d/d	10 0 0
Do. 3 in., d/d	12 0 0
Scotch firebricks, 2½ in., f.o.r.	12 15 0
Do. 3 in., f.o.r.	15 7 6
Sheffield quality, 2½ in., f.o.r.	11 0 0
Do. 3 in., f.o.r.	13 5 0
Silica bricks (ord.), 2½ in., f.o.r.	15 10 6
Do. 3 in., f.o.r.	18 12 6

All per 1,000 bricks.

	£ s. d.
Basic Dolomite ..	3 18 0
Dead burnt magnesite (peas and powder), d/d ..	26 0 0
Ground fireclay	1 10 0 to 2 0 0
Ganister	1 10 0 to 1 12 6

TINPLATES.

I.C. Cokes, 20×14, box	33/–
,, 28×20, ,,	66/–
,, 20×10, ,,	47/–
,, 18¾×14, ,,	36/–
Terneplates, 28×20, ,,	70/–

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Feb. 2	69 5 0	dec. 5/–
,, 3	68 5 0	,, 20/–
,, 4	69 15 0	inc. 30/–
,, 7	72 0 0	,, 45/–
,, 8	72 0 0	No change

Standard Tin (cash).

Feb. 2	162 10 0	dec. 120/–
,, 3	155 10 0	,, 140/–
,, 4	164 0 0	inc. 180/–
,, 7	166 10 0	,, 50/–
,, 8	164 0 0	dec. 50/–

Zinc Sheets (spot).

Feb. 2	39 0 0	dec. 20/–
,, 3	39 0 0	No change
,, 4	39 0 0	No change
,, 7	39 0 0	No change
,, 8	39 0 0	No change

Spelter (ordinary).

Feb. 2	23 15 0	dec. 10/–
,, 3	23 10 0	,, 5/–
,, 4	24 0 0	inc. 10/–
,, 7	24 10 0	,, 10/–
,, 8	25 7 6	,, 17/6

Lead (English).

Feb. 2	25 0 0	No change
,, 3	24 10 0	dec. 10/–
,, 4	24 10 0	No change
,, 7	24 10 0	No change
,, 8	24 10 0	No change

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

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Sun, Wellington, Salop.
Sunbrand (Cannon), London.

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To all Specifications.

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Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

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Delivered F.O.B. Liverpool.
BARS, ANGLES, TEES and PLATES.

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MILD STEEL (up to 2in. wide)
Marked
"HEATH'S SOFT STEEL."

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COPPER — ANTIMONY—MANGANESE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

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FOUNDRY FOREMAN WANTED, must be good, practical man, used to core work; also understand mixing of metal. Able to control men, non-Society. Constant job for good man. State wages required.—Apply, Box 676, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

OPENING occurs for one thoroughly experienced first-class Jobbing Moulder. One with experience of Steam and Electric Crane work preferred, and used to striking up work in green sand and loam work, not of large, but medium dimensions. A sound and permanent job for a thoroughly experienced man.—Apply Box 674, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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PERSHORE CATTLE MARKET.—For immediate disposal as standing or F.O.R. Pershore,

No. 92 C.I. posts and 7 stoops, 5 ft. high. Approximate weight 7 tons.

No. 13 W.I. gates, 5 ft. wide, 4 ft. 6 in. high. Approximate weight 16 cwt.

1,750 ft. line W.I. 1½ piping. Approximate weight 35 cwt.

No. 100 Sheep Pens, containing :—

No. 104 Gates W.I., 4 ft. wide, 2 ft. 4 in. high. Approximate weight 2 tons.

No. 104 W.I. division hurdles. Approximate weight 2 tons.

212 ft. line division fencing, 2 ft. 6 in. high. Approximate weight 12 cwt.

212 ft. line handrail in 1 in. piping. Approximate weight 5 cwt.

Block of No. 33 sheep pens.

No. 34 division hurdles, each 7 ft. 3 in. long, 2 ft. 9 in. high. Approximate weight 17 cwt.

No. 33 W.I. gates, each 4 ft. x 2 ft. 4 in. high. Approximate weight 14 cwt.

No. 25 C.I. stops. Approximate weight 4 cwt..

340 ft. line, 11 x 2. Timber footboard.

Can be seen by appointment.—Offers to JOHN KNOX, Building Contractor, Evesham, Worcs.

WANTED, immediately, 2,000 ft. .937 Hex. across flats bright mild steel. State lowest price and delivery.—Box 672, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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LIMESTONE, Raw for Blast Furnaces, etc. Finest Quality.—Prices from KNOWLE LIME WORKS, Presthorpe, Salop.

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WANTED all users of METALLIC CEMENT to buy our PEERLESS brand, which produces "Artificial Iron" 10 lb. tin 10s., free delivered.—WILLIAM OLSEN, LTD., Cogan Street, Hull.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 165, Queen Victoria Street, E.C.4.

FOR SALE, as a going concern, an established Sheffield Cutlery business, with clear title to world-famed name; owner retiring.—Apply, Box 654, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

IN LIQUIDATION.—Rockingham Ironfoundry Co., Ltd., Cotton Road, Nuneaton. The assets of the above company are for sale.—Full particulars can be obtained from C. R. MILES, 20, Friar Lane, Leicester, Liquidator.

PATTERNS SUPPLIED WHICH GIVE SATISFACTION. Inquiries solicited. Quotations by return of post or telephone. You can secure good-class work, reasonable prices, and promptitude in delivery by placing your orders with VIDEX ENGINEERS' PATTERN WORKS, 22, Huntsworth Mews, Upper Baker Street, London, N.W.1 (Telephone, Paddington 364).

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FOR SALE.—1 new No. 6 Ajax Jarring Turnover and Pattern Drawing Moulding Machine; maximum size of box 25 in x 25 in. x 18 in., pattern lift 14 in. 1 Ingersoll Rand Air Compressor, 7 in. x 6 in., class E.R.1, for 80/100 lbs. pressure.—H. L. RAPHAELS'S REFINERY, Thomas Street, E.14.

MACHINERY—*Cont*

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HORIZONTAL STEAM ENGINE, 14-in. cyls., 12-in. stroke, by J. Davis & Sons.

HORIZONTAL ENGINE, with shaft governors, 18-in. cyls., 36-in. stroke, by E. R. & F. Turner.

POWERFUL PLANING MACHINE, to plane 14 x 5 x 4, with 2 tool boxes, by Buckton & Co., Ltd.

No. 2 "Brown & Sharp" VERTICAL MILLING MACHINE.

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Three No. 3 "Ryerson-Conradson" HIGH-POWER PLAIN MILLING MACHINES.

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No. 2 "Kempsmith" UNIVERSAL MILLING MACHINE, with vertical attachment and equipment.

HORIZONTAL BORING MACHINE, with Tee-Slotted Table, 3 ft. 6 in. x 3 ft. 6 in., by Noble & Lund.

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FOR SALE.—5 ft. 6 in diameter Drop Bottom Cupola (Thwaites), complete with 20-cwt. Electric Hoist and Charging platform; quite new, never been used.—R. RUSSELL & SONS, LIMITED, Derby.

HAMMOND AND BOTTOMLEY,
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METAL AND MACHINERY MERCHANTS,
Specialising in
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MOULDING MACHINES.

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Cupola, brand new, Capacity 12-15 tons per hour.

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Large Room Plant, room 8 ft. 6 in. sq., by Tilghmans, no compressor.

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